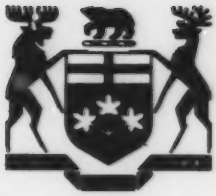

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Geology of the
Finlayson Lake Area
District of Rainy River

Compliments of
ONTARIO
MINISTRY OF NORTHERN DEVELOPMENT
AND MINES
K. G. Fenwick

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GEOLOGICAL MAPS

(back pocket)

Map 2297 (Coloured)–Finlayson Lake, District of Rainy River.
Scale 1 inch to ½ mile (1:31,680).

Map 2298 (Coloured)–Marmion Lake, District of Rainy River.
Scale 1 inch to ½ mile (1:31,680).

ABSTRACT

This report describes the geology, structure and mineral deposits of the Finlayson Lake area, District of Rainy River. The map-area covers approximately 210 square miles (544 km²) and lies about 7 miles (11 km) north of the town of Atikokan.

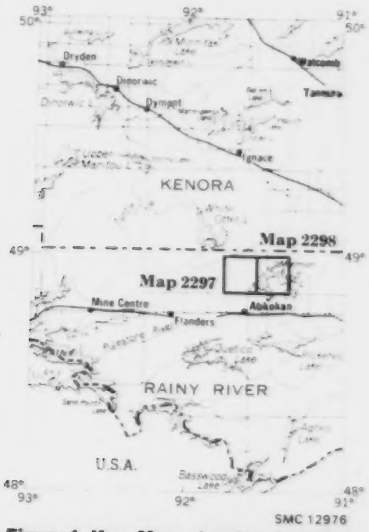

Figure 1–Key Map showing location of the Finlayson Lake Area. Scale 1 inch to 50 miles (1:3,168,000).

All bedrock in the area is Precambrian in age. Finlayson Lake is underlain by metavolcanics and metasediments that form a narrow belt, which is 15 miles (24.0 km) long, and varies in width from ½ to 3½ miles (0.8 to 5.6 km). This belt consists of four distinct units which are; the lower mafic metavolcanic unit, the felsic metavolcanic unit, the metasedimentary unit, and the upper mafic metavolcanic unit. The lower mafic metavolcanic unit is mainly composed of basalt flows. The felsic metavolcanic unit is predominantly pyroclastic in origin. The metasedimentary unit overlies the felsic metavolcanic unit and is overlain by the upper mafic metavolcanic unit. Greywacke and argillite predominate in this metasedimentary unit. In the upper mafic metavolcanic unit, pillowed basalt and andesite are common, and are found overlying the metasediments and the felsic metavolcanic unit. The granitic rocks on the east side of the belt are trondhjemite, quartz porphyry, and quartz-sericite schist in areas of intense shearing. Biotite granite, quartz monzonite, granitic gneiss and trondhjemite are the principal granitic rocks on the west side of the belt. Diabase and lamprophyre dikes intrude the metavolcanics and metasediments.

Pleistocene deposits consist of till, gravel, sand and varved clays.

The belt is isoclinally folded and is downfolded between, and intruded by two granitic masses that are possibly of different age. The large-scale syncline and prominent northeasterly trending lineaments in the map-area are all parallel to the axis of the belt. A minor northwesterly trending synform is superimposed on the major syncline, on the west side of Finlayson Lake.

Many gold showings are close to the northeasterly trending lineaments in the sodic-rich Marmion Lake Batholith.

Massive pyrite deposits occur in the uppermost felsic part of a well-differentiated Early Precambrian volcanic pile and appear to be confined to a particular stratigraphic unit.

Massive pyrrhotite deposits with pyrite concretions and minor chalcopyrite are found associated with 'cherty iron formation' within the upper mafic metavolcanic unit, the felsic metavolcanic unit and near the contact between the metavolcanics and metasediments.

Geology

of the

Finlayson Lake Area

District of Rainy River

by

K. G. Fenwick[1]

INTRODUCTION

The Finlayson Lake area was mapped by the author for the Ontario Division of Mines during the field seasons of 1967 and 1968, and lies in the Rainy River District of northwestern Ontario. The map-area covers approximately 210 square miles (544 km^2) and is bounded by Latitudes 48°50′ and 49°00′ and Longitudes 91°21′ and 91°45′. The area is 125 miles (201 km) west-northwest of Thunder Bay, Ontario (Figure 1).

Geological mapping was done by standard pace-and-compass traverses inland, and canoe traverses along the shoreline, using vertical aerial photographs. Traverses within the metavolcanic-metasedimentary belt were made 1,320 feet (400 m) apart, except where the geological complexities demanded more detailed mapping. Traverses were, in most places perpendicular to the strike of the rock units. However, traverses within the granitic rocks were made approximately 1 mile (1.6 km) apart.

Geological data gathered in the field were plotted on transparent acetate overlays on aerial photographs having a scale of 1 inch to ¼ mile (1:15,840). The outcrops located in the field were then generalized, and transferred to a cronaflex basemap at a scale of 1 inch to ¼ mile (1:15,840) prepared by the Cartography Section, Surveys and Mapping Branch, Ontario Ministry of Natural Resources[2].

The aerial photographs at a scale of 1 inch to ¼ mile (1:15,840), were obtained from the Air Photo Library, Administrative Services, Ontario Ministry of Natural Resources, Toronto. Those aerial photographs at a scale of 1 inch to 1 mile (1:63,360), were obtained from the National Air Photo Library in Ottawa, and were used to interpret the regional structure of the map-area. The following ODM-GSC Aeromagnetic Maps were also used by the author to interpret the geology of the map-area: The Sapawe Sheet, Map 1123G, the Gulliver Lake Sheet, Map 1124G, the White Otter Lake Sheet, Map 1134G, and the Steep Rock Sheet, Map 1133G.

Geological maps (Maps 2297 and 2298 in back pocket) at a scale 1 inch to ½ mile (1:31,680) represent a compilation of all previous geological work done by the author.

[1]Regional Geologist, Ontario Ministry of Natural Resources, Thunder Bay. Manuscript accepted for publication by the Chief Geologist, 28 December, 1971.

[2]Since this report was written, the Ontario Government was reorganized into various large ministries on April 1st, 1972.

Finlayson Lake Area

Preliminary geological maps covering the map-area, P.542 and P.543, were released in 1969 (Fenwick 1969 a and b).

Means of Access

The south end of Finlayson Lake is 16 miles (25.7 km) by road from the town of Atikokan. This road passes by the south end of Marmion Lake, which provides ready access by water to most parts of the eastern half of the map-area.

The western half of the map-area can be reached from the south end of Finlayson Lake by using the timber-roads of the Ontario-Minnesota Pulp and Paper Company Limited. Special permission from the company is needed to use these roads.

Previous Geological Work

The area received considerable attention from prospectors and geologists in the late 1890s. The Sawbill and Hammond Reef Gold Mines were operating at this time. Shafts and trenches were also put down in the area at the following sites: New Golden Twins Mine, Big Six Mine, Golden Winner Mine, Jack Lake Mine and Plator Gralouise Gold Mine.

J.E. Hawley (1929) mapped the area southeast of the Finlayson Lake area.

E.S. Moore (1939) and in 1953, the Development Department of the Canadian Pacific Railway (Bartley 1954) did reconnaissance surveys of the map-area. Moore's work was the most recent government report and map, and was done before the lake was lowered to its present level.

R.S. Woolverton, in 1951 and 1952, mapped the Lumby Lake area (Woolverton 1960) which ties on to the northeast corner of the map-area.

R. Shklanka (1972) mapped the Steeprock Lake area in 1964 and 1965 which is directly south of Finlayson Lake.

The Atikokan-Lakehead Sheet (Pye and Fenwick 1965) is a compilation of all the geological information on the district and includes the map-area covered in this report.

Acknowledgments

During the field work, able assistance was given by the following university graduates and undergraduate students: A.G. Kidston, C.R. Allen, M.E. Van Nispen, A. Romanoff and R. Keele in 1967; L.C. Gobeil, D. Rhodes, C.R. Allen and A. Romanoff in 1968. Messrs. Kidston and Gobeil, as senior assistants, were engaged in independent mapping during their employment.

Thanks are extended to the members of the Ontario Department of Lands and Forests at Atikokan, for their hospitality and co-operation, and for valuable information concerning the area.

Grateful acknowledgment is made to Dr. V.G. Milne, Chief Geologist for the Ontario Division of Mines who visited the author in the field, and gave advice regarding the

map-area during the 1968 season; and to Drs. J. Kalliokoski, D. Pollock, and B. Hamil, who are professors at Michigan Technological University, Houghton, Michigan, and who aided the author in the preparation of parts of this report.

Thanks are also due the Ontario-Minnesota Pulp and Paper Company Limited for permitting the field party, in 1967 and 1968, to use their timber-roads for access to the area.

Topography and Drainage

Before 1942, Finlayson Lake drained into Marmion Lake and then south through Steeprock Lake to the Lower Seine River waterway (Figure 2).

With the discovery of rich iron orebodies in Steeprock Lake, it became necessary to drain Steeprock Lake. The waters of the river which previously had entered Steeprock Lake at the northeast corner of Falls Bay, were now diverted to flow around Steeprock Lake by way of Finlayson, Barr, Reed and Modred Lakes.

Diversion channels had to be excavated between Raft Lake and Finlayson Lake and through the end moraine at the south end of Finlayson Lake (Skillings 1946). The Finlayson Lake drainage tunnel was blown through at noon on July 23, 1943 and thereafter the lake level fell gradually (Tanton 1944).

From 1955 to 1960, Marmion Lake was used as a disposal basin for 145,000,000 cubic yards (1,108,600 m^3) of silt dredged from Caland Ore Company Limited property in the Falls Bay area of Steeprock Lake. Three dams were constructed at the north end of Marmion Lake to separate the disposal basin from the Seine River (Scott 1961).

The Seine River drains westward into Rainy River and Rainy Lake. Water from Rainy Lake passes through the Lake of the Woods, Lake Winnipeg and the Nelson River into Hudson Bay.

The topography of the area is typical of Precambrian Shield terrain. The metavolcanics and metasediments are present as rocky hills alternating with lakes, marshes and drift-covered lowlands. The granitic areas to the east and west present a more rolling surface.

The bedrock elevation varies from 1,600 feet (490 m) above mean sea level in the northwestern part of the map-area to 1,400 feet (430 m) in the northeastern part of the map-area. The elevation of the Marmion Lake basin is now 1,363 feet (415.4 m) above mean sea level, and has been raised from 1,308 feet (398.7 m) by 55 feet (16.7 m) by dams (Antevs 1951). The above elevations are taken from Quetico Topographic Map 52B, Department of Energy, Mines and Resources, Canada. The Finlayson Lake elevation has dropped from 1,398 feet (426.1 m) to 1,340 feet (408 m) above mean sea level (Pye 1968).

The present topography appears to be the result of a combination of structural control and glaciation. The end moraine at the south end of Finlayson and Marmion lakes is perpendicular to the northeasterly trending lineaments (Photo 1). Therefore, the glacier flowed down the structural troughs.

The flooding of Marmion Lake by 55 feet (16.7 m) has moved the shoreline back in places as much as a quarter of a mile (0.4 km) and has resulted in the drowning of the shoreline trees. Travel by boat or floatcraft is very hazardous along the shoreline because of many hidden stumps and logs.

The lowering of Finlayson Lake has exposed up to half a mile (0.8 km) of shoreline and islands that previously were below water (Photo 1).

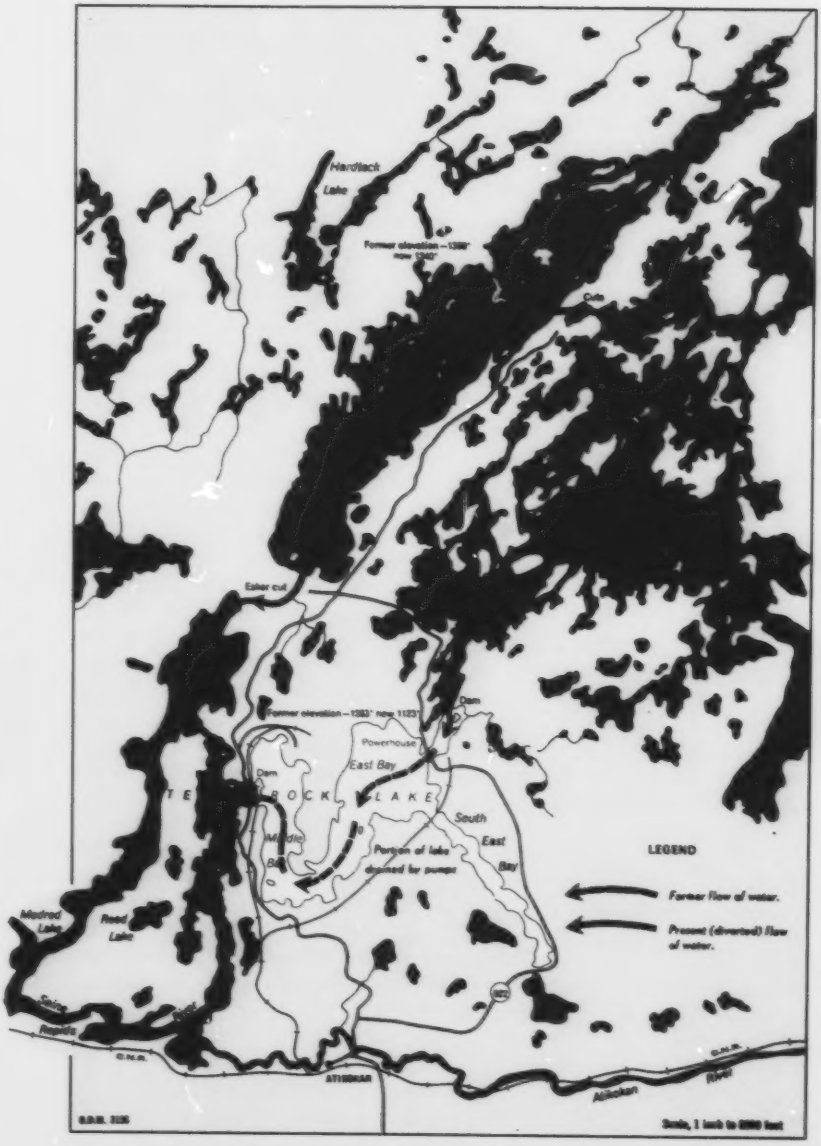

Figure 2–Topographic map showing the change in direction of water flow caused by the Seine River Diversion around Steeprock Lake (after Pye 1968, p.57).

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Photo 1—The end moraine at the south end of Finlayson and Marmion lakes is perpendicular to the structural troughs in these lakes. The photo was taken at an altitude of 35,000 feet (10,700 m) above sea-level with a 5.970 inch lens in September, 1952. Scale, 1 inch to 1 mile (1:63,360).

Forests and Lumbering

Trees found in this region are black and white spruce, poplar, white birch, jack pine and balsam. White cedar, tamarack, speckled alder and black ash grow in the swamps and along the creek banks.

The Ontario-Minnesota Pulp and Paper Company Limited has a large camp at the south end of Finlayson Lake and holds the timber concession in the area. They are mainly interested in jack pine, and white and black spruce.

Fish and Game

Moose, bear and grouse were seen during the summer. Northern pike and pickerel (Walleye) are found in many of the lakes in the area. Finlayson Lake was formerly known as Clearwater Lake and was noted for its large lake trout. Brook trout were noted in a small stream that flows south of Coulson Lake into Eye Lake.

GENERAL GEOLOGY

The Finlayson Lake area lies within the Wabigoon Belt (Wanless *et al.* 1968). On the north and south side of the Wabigoon Belt are the English River and Quetico Belts which consist mainly of metasediments, migmatite, and granitic bodies. The Wabigoon Belt is characterized by curvilinear structures which are formed by sedimentary and volcanic rocks that have been invaded by granitic batholiths (Stockwell 1964).

Kalliokoski (1968, p.1,202) suggests that the Keewatin (Early Precambrian) belt of lavas (Wanless's Wabigoon Belt) that lie between the English River and Quetico Belts constitute part of an east-northeast complex, and proposes that the trend of the constituent belt of rocks can be used as a criterion to define the limits of the Kenoran Orogeny.

All bedrock in the map-area is of Precambrian age (Table 1). The Finlayson Lake map-area is underlain by metavolcanics and metasediments that form a narrow belt, which is approximately 15 miles (24 km) long and varies in width from ½ to 3½ miles (0.8 to 5.6 km). The south and west parts of this belt were mapped during the 1967 field season and the north and east parts mapped in 1968. The north end of the Finlayson Lake Belt trends northeast and appears to be continuous with the greenstone belt in the Lumby Lake area. The Lumby Lake portion of the belt was mapped for the Ontario Department of Mines by Woolverton (1960).

The belt trends southwest into the Steeprock Lake area that was recently mapped for the Ontario Department of Mines by Shklanka (1968; 1972). Shklanka (1968, p.53) wrote the following:

> Northwest of the Rawn Lake Fault, a lower sequence of dominantly mafic volcanic flows intercalated with intermediate volcanic flows, intermediate to felsic tuff and at least one thin arkosic grit-conglomerate member is succeeded by a unit of undetermined thickness composed of arkosic grit with minor amounts of interbedded mafic tuff.

Table 1 | Table of Lithologic Units for the Finlayson Lake Area

PRECAMBRIAN

CENOZOIC

QUATERNARY

RECENT

Lake, stream and swamp deposits

PLEISTOCENE

Sand, gravel, clay, varved clay

Unconformity

PHANEROZOIC

EARLY PRECAMBRIAN (ARCHEAN)

MAFIC INTRUSIVE ROCKS

Diabase dikes, lamprophyre dikes, and andesite dikes

Intrusive Contact

FELSIC INTRUSIVE ROCKS

DASHWA LAKE BATHOLITH

Biotite and hornblende granite, quartz monzonite, granite gneiss, quartz monzonite gneiss, porphyritic trondhjemite, feldspar quartz porphyry, mylonite, migmatite, aplite pegmatite

Contact Relations Uncertain

MARMION LAKE BATHOLITH

Biotite and hornblende trondhjemite; quartz-sericite schist; complex of quartz porphyry dikes, mafic dikes, and mafic volcanic rocks

Intrusive Contact

METASEDIMENTS

Conglomerate, greywacke, arkosic grit, quartzite, graphitic argillite, phyllite, slate, schist, intercalated sedimentary rocks and volcanic rocks, iron formation

METAVOLCANICS AND METASEDIMENTS

FELSIC TO INTERMEDIATE METAVOLCANICS

Massive and laminated lavas, quartz-sericite schist, tuff, agglomerate, pillow lava, feldspar porphyry, foliated volcanic rocks of intermediate composition intercalated with mafic tuff and lava, iron formation

MAFIC TO INTERMEDIATE METAVOLCANICS

Massive lava, chlorite schist, chlorite-carbonate schist, pillow lava, tuff, agglomerate, amphibolite and amphibolite schist, coarse-grained lava or mafic intrusive rocks, amphibolite and intercalated sedimentary rocks, iron formation

Finlayson Lake Area

The metavolcanics of the Finlayson Lake Belt are predominantly mafic to intermediate lava and amphibolite on the west, felsic to intermediate lava and tuff and mafic pillow lava in the centre, and intermediate to mafic lava on the east.

The metasediments consist of conglomerate, argillite, greywacke, slate, and schists derived from these rocks. These metasediments are found mainly intercalated with the metavolcanics.

The granitic rocks on the east side of the metavolcanic-metasedimentary belt, are trondhjemite, quartz porphyry, and quartz-sericite schists. Along the contact zone the rocks consist of a complex of mafic metavolcanics, quartz porphyry and metadiorite.

Biotite and hornblende granite, quartz monzonite, granite gneiss and trondhjemite are the principal igneous rocks on the west side of the belt.

Diabase and lamprophyre dikes intrude the metavolcanics and metasediments.

Pleistocene deposits consist of till, gravel, sand and varved clay.

Rock types in the map-area are shown in Table 1.

Precambrian

EARLY PRECAMBRIAN (ARCHEAN)

Metavolcanics

The metavolcanics in the map-area have been divided into two major rock units; the mafic to intermediate metavolcanics, and the felsic to intermediate metavolcanics. In the field, colour index was used to subdivide the metavolcanics into these groups. Mafic volcanic rocks grade into felsic volcanic rocks, tuff, and then to sedimentary rocks from the edge to the centre of the Finlayson Lake Belt. The intimate intercalation of these rocks would suggest that they were deposited contemporaneously.

MAFIC TO INTERMEDIATE METAVOLCANICS

Mafic to intermediate metavolcanics of the Finlayson Lake Belt include massive lava, pillow lava, medium-grained to coarse-grained lava flows and or intrusive rocks, fragmental rocks, tuff, and their derived metamorphic equivalents. Mafic to intermediate metavolcanics are associated with minor quantities of interflow sedimentary rocks and felsic metavolcanics. The author has subdivided the rocks of the area (for the purpose of this report) into four distinct units; the lower mafic metavolcanic unit, the felsic metavolcanic unit, the metasedimentary unit and the upper mafic metavolcanic unit. Because the lower and upper mafic metavolcanic units are found north of Snake Island without any intervening felsic metavolcanic or metasedimentary unit, these rocks are not subdivided as lower and upper in the map legend, nor are they shown in Table 1.

The lava flows have been highly recrystallized and altered to a felt-like network of chlorite, actinolite, epidote, carbonate, feldspar and quartz with little indication of the primary minerals. They weather from dark green to black to grey-green to light green,

ODM9274

Photo 2–Water-washed surface of mafic metavolcanics, on the islands in central part of Finlayson Lake.

and the fresh surfaces are similar to the weathered surfaces in colour. The typical metamorphosed volcanic rocks are fine grained to medium grained and range from massive to moderately schistose. Numerous quartz blebs, ankerite and calcite stringers were noted in the area. Very few flow contacts were recognized and, therefore, no information is available on flow thickness.

Columnar jointing was noted in the mafic metavolcanics along the southwest side of Finlayson Lake, and, in places, resulted in great talus slopes of columnar-jointed blocks. Water-washed surfaces (Photo 2) predominate in the mafic metavolcanic outcrops on the islands and southwest shore of Finlayson Lake.

Pillowed flows are very common in the central part of the Finlayson Lake Belt (upper mafic unit) and have proved invaluable in outlining the major fold structure. The pillows are generally small, and seldom exceed 2 feet (0.6 m) by 1 foot (0.3 m) in width and have narrow selvages. Individual pillowed flow units can rarely be recognized. On Snake Island and the island to the north in Finlayson Lake the pillows are well displayed. The pillows on the west shore of Finlayson Lake have been highly deformed with intense flattening and stretching. They are locally present but not abundant in the lower mafic unit. The light green colour of the pillow lavas suggested that they might be of andesitic composition: however the chemical analysis (Table 2) of a sample from Snake Island indicates a composition intermediate between andesite and basalt.

In several places a porphyritic andesite is exposed. The white feldspathic phenocrysts, up to 2 cm in size, may comprise 25 percent of the rock. This rock has been termed 'leopard rock', and 'golf ball porphyry' by prospectors and geologists (Woolverton 1960, p.7). In thin section, this rock is made up of a fine-grained to medium-grained aggregate of chlorite, carbonate, amphibole, untwinned feldspar and quartz. The plagioclase phenocrysts are euhedral and completely saussuritized.

Table 2 CHEMICAL COMPOSITION, OF THE VOLCANIC AND SEDIMENTARY ROCKS FROM THE FINLAYSON LAKE AREA, COMPARED TO THE AVERAGE COMPOSITION OF CANADIAN ARCHEAN ROCKS; CHEMICAL ANALYSES BY MINERAL RESEARCH BRANCH, ONTARIO DIVISION OF MINES.

Sample No.	1	2	3	4	5	6	7	8
SiO_2	51.40	54.70	59.20	61.50	72.40	72.43	63.90	61.52
Al_2O_3	14.40	15.00	13.40	15.70	14.10	14.23	12.40	13.42
Fe_2O_3	2.09	2.00	1.04	1.83	0.43	0.84	1.44	1.72
FeO	8.17	7.64	5.50	4.49	1.57	1.54	5.66	4.45
MgO	4.67	4.50	2.65	2.38	0.70	1.47	2.82	3.39
CaO	10.90	6.39	4.15	4.41	2.54	0.88	2.81	3.56
Na_2O	1.90	2.79	5.05	3.15	3.69	4.67	1.70	3.73
K_2O	0.22	0.55	0.35	1.16	1.23	1.32	1.65	2.17
H_2O+	2.10	2.92	2.46	2.27	2.14	1.01	2.06	2.33
H_2O-	0.25		0.18		0.19		0.21	0.06
CO_2	1.40	1.93	3.50	2.18	2.14	0.58	3.72	3.04
TiO_2	0.91	0.99	0.61	0.63	0.17	0.16	0.80	0.62
P_2O_5	0.09	0.12	0.07	0.12	0.05	0.20	0.06	——
S	0.02	——	0.13	——	0.01	——	0.17	——
MnO	0.26	0.28	0.20	0.16	0.04	0.02	0.15	——
Total	98.8	——	98.5	——	101.4	99.38	99.6	100.01
Specific Gravity	2.93	ND	2.55	ND	2.65	ND	2.70	ND

NOTES:

1. Pillowed Lava, island northeast of Snake Island.
2. Average chemical composition of Archean andesite in Superior Province of Canadian Shield (Goodwin 1968, p.75).
3. Felsic carbonatized pillow lava—east shore of Finlayson Lake.
4. Average chemical composition of Archean dacite in Superior Province of Canadian Shield (Goodwin 1968, p.75).
5. Felsic tuff—north shore of Copper Hook Lake.
6. Average chemical composition of Canadian Archean Na-rhyolite (Wilson *et al.*, 1965, p.167).
7. Greywacke—southeast tip of Snake Island.
8. Average chemical composition of Archean greywacke from Kirkland Lake, Ontario (Pettijohn 1957, p.306).

—— Not detected.
ND Not determined.

Chlorite schist, chlorite-carbonate schist and amphibolite schist have been derived by regional and dynamic metamorphism of the mafic to intermediate volcanic rocks. These rocks are very soft, weather light green to dark green to brown, and locally have been drag folded. These rocks are very prominent along the west side of Finlayson Lake. They are found in areas of intense shearing, and the schistosity has obliterated the primary volcanic structures.

Soft chlorite schist, and chlorite-carbonate schist that show faint banding are intercalated with the pillow lava. The writer thinks that these rocks were tuffs which were more incompetent than the lava, and therefore suffered more intense shearing. A few

narrow beds of agglomerate were also noted within the Finlayson Lake Belt separating lava flows; this volcanic pyroclastic rock is more common in the central part than at the margins of this belt.

Along the west side of the Finlayson Lake Belt an amphibolite is found intercalated at frequent intervals with the massive mafic flows. The amphibolite is dark-grey to black, fine to medium grained, and strongly foliated. There is a pronounced foliation caused by the subparallel alignment of prismatic amphibole crystals. Locally, the amphibolite is laminated with light green layers rich in amphibole that alternate with medium grey layers rich in plagioclase and quartz. These laminated rocks are mainly metamorphosed flows, but originally banded tuffaceous rocks are probably also present. Locally, amphibolite was noted grading into coarse-grained massive phases of flows or intrusive rocks. Microscopic examination shows that typical specimens consist of about 70 percent light green to blue-green amphibole, with plagioclase and quartz and small amounts of epidote, apatite and magnetite. Along the west shore of the narrow lake south of Copper Hook Lake, the amphibolite contains garnet.

A sequence of rocks, originally mapped as intercalated metasediments and metavolcanics (3h) on Map P.542, is exposed south of Hardtack Lake, and along the northeast-trending logging road. A re-examination of several outcrops and a thin-section study, has convinced the author that these rocks are mainly volcanic in origin. The rocks have a felsic appearance in hand specimen, but thin section work indicates that the rocks are composed of 25 to 40 percent mafic minerals (amphibole, biotite and chlorite). Relict pillow structures and vesicles were seen in isolated outcrops. As a result, the rock has been called an intermediate amphibolite and placed with the mafic to intermediate metavolcanics. The reason for placing these rocks with the mafic metavolcanics instead of the felsic metavolcanics, is because the intermediate amphibolite grades, in places, into fine-grained and medium-grained mafic amphibolite. Normally, the amphibolite is weakly to well foliated but in places sprays or clusters of amphibole (metacrysts) occur. Dark grey layers rich in amphibole, chlorite, and/or biotite alternate with medium grey layers rich in plagioclase and quartz.

On the origin of this type of rock, van de Kamp (1969, p.1,135) made the following statement:

> Studies of these amphibolites and others from Ontario and Scotland, which are obvious metasediments (van de Kamp 1967), indicate that all are formed from basic and intermediate igneous materials. This fact, combined with the demonstrated problems of producing hornblende-plagioclase rocks from shale-carbonate mixtures, suggests that nearly all amphibolites are derived from basic igneous rocks, even if they appear as metasediments. A few amphibolites may represent metasomatized sediments.

The present author believes that this amphibolite has been derived from an intermediate volcanic rock.

Thin-layered yellow quartz-sericite schist (felsic meta-tuff?) with small seams of pyrite was noted intercalated with amphibolite just south of Hardtack Lake.

Pale grey to grey, fine-grained micaceous quartzite and micaceous arkose are found locally as interflow metasediments intercalated with the intermediate amphibolite. The micaceous quartzite contains up to 80 percent fine-grained quartz together with fine-grained biotite, accessory plagioclase, chlorite and epidote. The micaceous arkose contains approximately equal parts quartz and plagioclase, and also 10 to 20 percent of biotite, muscovite, chlorite and accessory epidote.

A thin section of a coarse-grained well foliated amphibolite, 1¼ miles (2 km) south of the southeast bay of Hardtack Lake, contains actinolite with a poikiloblastic texture

containing numerous quartz and feldspar inclusions.

Disseminated pyrite is present in much of the mafic metavolcanic unit. Veins, lenses and stringers of clear, milky or blue quartz are common in the metavolcanics. Small lenses and fracture planes coated with recrystallized carbonate are also common.

Coarse- to medium- to fine-grained, massive to schistose metadiorite exists at intervals throughout the entire 'greenstone' belt and is intimately associated with the metavolcanics and also the metasediments. Rarely has it been possible to recognize a gradation in texture from the coarse-grained metadiorite to fine-grained mafic lava or medium-grained amphibolite. In such a case metadiorite probably represents the relatively coarse-grained interior portion of thick lava flows. Elsewhere, metadiorite occurs as sills, and as irregular bodies with their long dimensions parallel to the regional northeast-trending schistosity. These mafic intrusions are probably associated with the same igneous activity that gave rise to the extrusive rocks. Later shearing has locally rendered the rocks highly schistose.

The metadiorite is dark grey to green on fresh surfaces, and weathers to a rough, speckled, white and green 'salt-and-pepper' appearance. In thin section, variable amounts of actinolitic amphibole, chlorite, epidote, and saussuritized plagioclase are the major constituents. Quartz, opaque iron oxide and leucoxene are usually present in minor amounts. Carbonate is variable, and in places, the rock contains up to 20 percent carbonate.

It is very difficult to distinguish between coarse-grained flows and metadiorite intrusions in the field. Separation of the two was not possible at the mapping scale used.

FELSIC TO INTERMEDIATE METAVOLCANICS

The rocks included under this heading consist of felsic to intermediate lava, intercalated felsic and minor pyroclastic rocks (tuff and agglomerate) and their derived metamorphic equivalents. Stratigraphically, this unit is thought to represent a volcanic 'Edifice Stage' (Goodwin 1968) that lies between, and is transitional to, the lower mafic metavolcanics and the metasediments (*see* section on 'Stratigraphy').

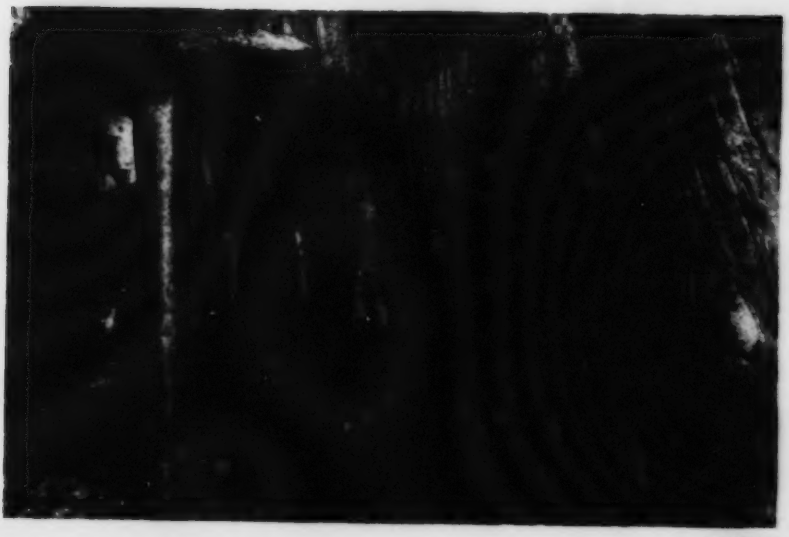
The felsic to intermediate rocks are prominent on both sides of the axial trace of the major syncline that strikes northeast under the central part of Finlayson Lake. The rocks have a strike-length of 11 miles (17.7 km) and dip vertically, or nearly so.

The greatest width of felsic to intermediate metavolcanics is found on the southeast shore of Finlayson Lake. Moore (1939) and Bartley (1954) have shown on their maps that this area is underlain by Timiskaming-type sedimentary rocks. The rocks in this area are characterized by intense shearing, chloritization and carbonatization. Therefore it is difficult in the field to distinguish between the fine-grained metasediments and the felsic to intermediate metavolcanics. Along the southeast shore of Finlayson Lake, relict pillow structures were locally noted in the fine-grained foliated felsic rock. Chemical analysis (Table 2) of this rock indicates that it is a dacite, and that its composition is quite distinct from that of a greywacke (*see* Table 2) from Snake Island. Also the interbedding of mafic tuffaceous rocks with the felsic rocks supports the view that the latter are mainly extrusive rocks. Little doubt exists that some sedimentary rocks also occur interbanded with the volcanic rocks in places.

The felsic metavolcanics exhibit rapid lateral and vertical changes in lithology, but are mainly massive flows and pyroclastic deposits that have a sodic rhyolite and dacitic composition. The rocks vary in colour on the fresh surface from white to yellow to pale green, and locally have a brownish hue caused by the presence of weathered ferruginous

ODM9275

Photo 3a–View of horizontal plane in stretched felsic agglomerate exposed on large island at the north end of Finlayson Lake.



ODM9276

Photo 3b–View of vertical plane in stretched felsic agglomerate exposed on large island at the north end of Finlayson Lake.

carbonate and pyrite. Generally they are extremely schistose, although some massive varieties were noted. They are distinguished from mafic to intermediate volcanic rocks in the area by the common occurrence in them of sericite.

Agglomerate and tuff are abundant at the north end of the Finlayson Lake Belt. An excellent exposure of agglomerate is on the southwest end of the large island at the north end of Finlayson Lake. Here, the light grey fragments are lenticular, more felsic than the dark grey or green matrix and are elongated parallel to the regional schistosity. The size of the fragments range from a fraction of an inch to nine inches (22.9 cm) long. Elongation of the fragments is more intense in the direction of dip than the strike direction (Photo 3 a and b). In thin section, the fragments are mainly composed of quartz, saussuritized plagioclase and minor chlorite. The matrix is chlorite- and epidote-rich, with minor quartz and carbonate, and forms between 15 to 75 percent of the rock.

Some of the rock mapped as fine-grained felsic flows may also be pyroclastic, because of the following. It is difficult to identify the fragments where the rock is poorly exposed; the fragments are in places sparse, and may have been altered to streaks or bands of chlorite and white mica by metamorphism.

The tuffaceous felsic rocks are commonly laminated or thin bedded, with bands ranging from a fraction of an inch to 6 inches (15.2 cm) wide. The laminated tuff, in thin section, shows quartz-rich laminae grading into thin, schistose laminae composed mainly of chlorite, carbonate and epidote.

Most of the felsic metavolcanics are aphanitic, but, in places are porphyritic and contain corroded, twinned, lathshaped to stubby albite phenocrysts up to 5 mm in size and/or small round quartz phenocrysts set in a fine-grained schistose matrix of quartz, feldspar, white mica, chlorite and carbonate. Pyrite, magnetite and leucoxene are minor accessory minerals.

Intercalated with the felsic metavolcanics are thinly bedded layers of conglomerate, greywacke, blue-grey slate, very lean iron formation and iron formation (sulphide facies) (*see* section on 'Economic Geology').

Flow layering was noted locally along the road west of Copper Hook Lake.

In many places in the map-area, the felsic volcanic rocks have a well-developed planar schistosity and break into thin slabs or plates. The highly schistose metavolcanics are found in shear zones, and are highly sericitized, carbonatized and pyritized. North of Copper Hook Lake, highly crenulated laminated felsic tuffaceous rocks were noted in shear zones.

Veins, swarms and stringers of milky and bluish quartz and brown to white carbonate are common, especially in the shear zones, and cut the felsic metavolcanics. Disseminated pyrite cubes are ubiquitous, and pyrite is often found to be an abundant accessory mineral.

Metasediments

Within the Finlayson Lake Belt, the sedimentary rocks are intimately associated with the volcanic rocks, and except for the iron formation, have been locally derived from the associated volcanic rocks. The sedimentary rock types include feldspathic greywacke, arkosic grit, argillite, slate, impure quartzite, pebble conglomerate and schists derived from these rocks.

The metasedimentary rocks strike northeasterly, and the various members dip vertically or nearly so. The rocks outcrop in a number of small, isolated areas: most appear to

lie along or near the trace of the axial plane of a major syncline that trends northeasterly along the centre of Finlayson Lake.

The southern part of the metasedimentary rock unit, which is southwest of the south end of Finlayson Lake, come into the map-area from the Steeprock Lake area. Shklanka (1968, p.30, 31) mapped this unit in detail and stated:

> Arkosic grit is most abundant northwest of Wagita Bay . . .
> The arkosic grits are buff or light to medium grey. Mineralogically, they resemble the greywackes although the proportion of micaceous matrix is usually less (5 to 30 percent by volume) and locally feldspar is absent. Detrital quartz and plagioclase grains are rounded to subangular, and medium-grained (1.0 to 5.0 mm). Bedding is well developed or poor, and commonly graded.
> . . . In the arkosic grits to the northwest of Wagita Bay, granulation and recrystallization obliterated much of the primary textures, except for the larger quartz and feldspar grains; scattered fragments (bombs) of intermediate volcanics were noted on the northwest shore of Barr Lake; conglomerate is absent; and numerous layers of basic volcanic tuff are interbedded.
> . . . Feldspar-free or deficient grits are quite abundant in the main unit to the northwest of Wagita Bay. In these rocks micaceous minerals are usually in the order of 5 to 10 percent of rock volume but may be more.

Phyllite occurs interbedded with arkosic grit. Shklanka (1968, p.28, 29) stated the following:

> The rocks (phyllite) are very fine-grained (0.02 to 0.10 mm) light grey to dark grey, and schistose. Chlorite and muscovite make up the bulk of the rock volume, chlorite predominating in the dark varieties and muscovite in the light. Quartz and sodic plagioclase are abundant both within the recrystallized micaceous matrix and as scattered and larger (0.05 to 0.20 mm) relict grains. Disseminated pyrite is in minor amounts; tourmaline and apatite are the other accessory minerals that may be present. Secondary carbonate is common.

The above descriptions constitute an accurate description of the arkosic grits and phyllites found in the southern sedimentary band in the Finlayson Lake map-area. Numerous layers of mafic volcanic tuff are also found intercalated in the metasedimentary rocks.

Two occurrences of polymictic pebble conglomerate were noted in the map-area, and occur on the southeast tip of Snake Island, and just east of the large island at the north end of Finlayson Lake. The conglomerate bed has a maximum thickness of 20 feet (6 m) at Snake Island, and a maximum width of 30 feet (9 m) at the north end of Finlayson Lake.

The conglomerate has a greywacke matrix and locally contains cobbles and a few boulders. The pebbles are subrounded to rounded, are usually 1 to 2 inches (2.5 to 5 cm) in diameter, and are elongated locally. The proportion of matrix exceeds that of the clasts. The clasts comprise quartz and feldspar porphyry, mafic metavolcanics, and quartz; the quartz and feldspar porphyry fragments predominate. The conglomerate is basal and passes vertically into greywacke.

Feldspathic greywacke forms the bulk of the metasediments and is found in the northern and central bands. The beds are distinct and vary in width from 1 inch (2.5 cm) to an observed maximum thickness of 2 feet (0.6 m). Excellent graded beds are observed and these beds exhibit gradations from grey sandy basal portions to dark-coloured fine-grained argillaceous tops.

The greywackes are medium to dark grey, fine grained and crudely schistose. A very fine grained matrix of muscovite, chlorite, quartz and sodic plagioclase forms around 50 percent (by volume) of these rocks. Imbedded in this matrix are subrounded to sub-angular grains of quartz and sericitized sodic plagioclase (up to 2.0 mm). Disseminated

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Photo 4–Pyrite-rich graphitic argillite, east of the most southerly island in Finlayson Lake.

hematite was noted as an alteration product of pyrite. Minor leucoxene and ankerite are also noted. The micaceous groundmass commonly exhibits a well-defined foliation.

A chemical analysis of the greywacke from Snake Island is presented in Table 2. The Mineral Research Branch, Ontario Division of Mines, who did the analysis stated:

> Chemically, the greywacke is slightly low in soda; the total femic oxides (MgO, FeO, Fe_2O_3) approximate a greywacke. Mineralogically the significant minerals are chlorite, mica, feldspar, quartz, ankerite, and pyrite. Some metamorphism has occurred and the rock it called a metagreywacke.

The fact that matrix minerals especially chlorite, embay and penetrate clastic grains supports the interpretation of a metamorphic origin for most fine-grained matrix minerals (Condie 1967, p.2,137).

The prevalence of graded bedding indicates a turbidity current origin (turbidites) for the greywacke.

Graphitic argillite and its metamorphic derivatives have been noted throughout the area: an interflow sediment (forms isolated lenses in the metavolcanics); within the main sedimentary sequence; within the footwalls of massive pyrite lenses (*see* 'Scheider Occurrence'); and finally genetically associated with the cherty iron formation. In thin section the graphitic argillite is composed essentially of equal parts of chert and graphite (opaque) with minor amounts of muscovite, chlorite and carbonate. The rock is black to dark grey in colour, well foliated and very fine grained. It can range in structure, from a dense, hard, bedded type, through slate, to a fissile graphite schist.

A 10-foot (3 m) wide lens of slate was noted, just east of the most southerly island in Finlayson Lake, interbedded with greywacke. Pyrite porphyroblasts, up to one and

one-half inches (3.8 cm) in size, with pressure shadows of fibrous quartz and carbonate were seen. Also at this location is a 3-foot (0.9 m) wide band of pyrite-rich graphitic argillite, shown as sulphide facies of Iron Formation (Gross 1965, p.88) on the map. The pyrite in this argillite shows fine-grained banding, oval bodies and possible colloform structures (Photo 4). These structures are considered primary. Minor deformation effects were noted, such as: the pyrite banding cut by quartz and euhedral pyrite-filled fractures; local folding of the argillite; and local brecciation of the pyrite. Evidently, metamorphic effects in the region are not extensive enough to completely destroy the primary structures in pyrite. This graphitic argillite is identical to the rock found at the footwall side of the massive pyrite lenses (*see* 'Scheider Occurrence').

An 8-foot (2.4 m) wide cherty iron formation, just north of the large island at the north end of Finlayson Lake, has a 1-foot (0.3 m) band of graphitic argillite interbanded with it.

Graphitic argillite in mafic metavolcanics occurs along the road to Sawbill Bay, just west of the north end of Copper Hook Lake, and is mineralized with pyrite, minor pyrrhotite, and chalcopyrite.

Woolverton (1960, p.26) in describing graphitic argillite, in the Lumby Lake area directly northeast of Finlayson Lake stated:

> The graphitic and concretionary argillite so resembles some post-Cambrian black marine shales that it must be concluded that it originated as a black mud, rich in organic material derived from primitive organisms. Pettijohn attributes an organic marine origin to the pyrite- and carbon-bearing greywackes and their associated slates in the Canadian Shield. Graphitic rocks in the Huronian of the Iron River area of Michigan, described by James, have been found to contain carbon of known organic origin.
>
> The lenses of graphitic argillite are considered to represent zones of stagnation or restricted circulation in the sedimentary basin in which organic material decayed, and in which iron brought into the basin was precipitated directly as sulphide concretions or as black sulphides of iron diagenetically changed to pyrite concretions.

IRON FORMATION

Narrow layers of banded siliceous rock with variable iron content are found as interflow sedimentary rocks within the upper mafic metavolcanic unit, the felsic metavolcanic unit, and near the contact between the metavolcanics and metasediments.

The cherty iron formation, has an iron content too low for it to be called an iron formation (Table 3). However, this seems to be the best term to apply to these rocks, because of their fine banding, contorted folded appearance and association with massive pyrrhotite deposits.

The thickest unit observed is thicker than 40 feet (12 m); the average is nearly 10 feet (3 m). The cherty iron formation is composed of layers of recrystallized chert with minor amounts of minnesotaite and stilpnomelane ½ to 1 inch (1.3 to 2.5 cm) thick. These layers are separated by thin bands, generally less than 0.2 inches (0.4 cm) thick, of pyrite, magnetite, stilpnomelane, minnesotaite, carbonate, chert and amphibole. Only minor magnetite was noted (less than 5 percent).

Massive pyrrhotite, concretionary pyrite, with minor chalcopyrite and graphitic schist are found associated with the cherty iron formation. The predominance of sulphides over magnetite, and the occurrence of graphite in the associated schists, suggest a strongly reducing depositional environment (James 1954).

Table 3 CHEMICAL COMPOSITION OF IRON FORMATION, CONCHILITE, IRON NODULES, CALCAREOUS CONCRETIONS, PYRITE CONCRETION, MASSIVE PYRITE, AND MASSIVE PYRRHOTITE FROM THE FINLAYSON LAKE AREA; CHEMICAL ANALYSES BY MINERAL RESEARCH BRANCH, ONTARIO DIVISION OF MINES.

Sample No.	1	2	3	4	5	6	7	8
SiO_2	66.30	12.60	2.71	49.70	44.30	—	—	—
Al_2O_3	1.95	4.27	1.48	11.10	10.00	—	—	—
Fe_2O_3	1.30	68.20	39.80	1.20	0.73	Fe-43.2	Fe-42.4	Fe-55.9
FeO	11.80	1.19	0.14	1.40	1.26	—	—	—
MgO	3.56	0.15	trace	0.96	0.83	—	—	—
CaO	6.14	0.67	trace	18.50	21.90	—	—	—
Na_2O	0.13	0.86	0.11	2.25	2.03	0.22	0.15	0.28
K_2O	0.13	0.12	0.12	1.70	1.48	0.11	0.16	0.10
H_2O+	0.85	8.57	8.45	0.40	0.49	—	—	—
H_2O-	0.10	1.41	5.25	0.06	0.16	—	—	—
CO_2	5.37	0.14	0.72	13.30	15.00	—	—	—
TiO_2	0.02	0.09	0.02	0.28	0.26	—	—	—
P_2O_5	0.08	0.02	0.00	0.08	0.15	0.01	0.02	0.01
S	0.64	0.20	0.17	0.05	0.02	50.00	50.40	38.20
MnO	0.64	0.23	18.20	0.38	0.78	—	—	—
Total	99.00	98.70	97.20	101.30	99.40	93.50	93.10	94.50
S.G.	2.83	3.22	2.74	2.67	2.63	4.64	4.50	4.38

NOTES:

1. Iron Formation—west shore of Finlayson Lake, main showing of Fin-Lan Copper Mines.
2. Conchilite—west shore of Finlayson Lake, main showing of Fin-Lan Copper Mines.
3. Brown iron nodules—same location as above.
4. Calcareous concretions—from west shore of Copper Hook Lake.
5. Calcareous concretions—from shore of the southwest bay of Copper Hook Lake.
6. Pyrite concretion—west shore of Finlayson Lake, main showing of Fin-Lan Copper Mines.
7. Massive pyrite—north end of small pond northeast of Copper Hook Lake, main showing of Burrex Mines Prospecting Syndicate.
8. Massive pyrrhotite—west shore of Finlayson Lake, main showing of Fin-Lan Copper Mines.

S.G. Specific Gravity.
— Not detected.

SULPHIDE FACIES

Pyritic carbonaceous argillite, deposits of banded pyrite and chert, and banded carbonate have been noted intercalated with and associated with the massive pyrite deposits of the map-area. A brief description of some of these occurrences follows.

A banded pyrite-chert deposit (Photo 5) was noted accompanying massive pyrite (footwall side) on the west shore of Copper Hook Lake. This deposit has been metamorphosed and folded.

The massive pyrite deposits along the east side of Finlayson Lake have thin lenses of pyritic carbonaceous argillite on their footwall sides or intercalated in them. Banded ferruginous chert is intercalated in the massive pyrite deposit on the east shore of Copper Hook Lake.

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Photo 5–Banded pyrite-chert deposit, west shore of Copper Hook Lake.

Banded carbonate, 1 foot (0.3 m) wide, was noted associated with massive pyrite on the southeast shore of the small bay which is one mile (1.6 km) west of the south end of Copper Hook Lake.

Gross (1965, p.88) stated that the sulphide facies of iron-formation occurs as follows:

> In the form of disseminated pyrite in black carbonaceous shale; as pyrite and pyrrhotite mixed with siderite and carbonate in banded chert or quartz; as distinct pyrite and pyrrhotite beds with minor siderite; as an oolitic textured pyrite member in black shale.

Both the iron and silica contributed to these formations appear to be the products of volcanic activity (Gross 1965, p.116).

Kinkel (1966, p.675) stated that deposits of chert, banded silica, and banded iron formation may be of volcanic origin, and that one or more of these may accompany massive pyrite, (related to volcanism) or highly carbonaceous shales in some deposits. Williams (1969, p.199) stated that the occurrence of a banded pyrite-chert deposit is suggestive of exhalative-sedimentary precipitation in a submarine environment on the sea floor and is intimately related to volcanism.

Massive pyrite deposits are often found associated with the sulphide facies iron formation, and therefore formed in a subaqueous environment at, or near the surface.

Stratigraphy

HISTORICAL INTRODUCTION

The stratigraphy of the Rainy River District and the Finlayson-Steeprock Lakes area represents the end-product of a complex geological history, the unravelling of which has introduced much controversy into the literature. Lawson, in 1886, stated that the volcanic rocks of the Lake of the Woods area, which were then called Huronian, were different from the original Huronian rocks at Lake Timiskaming and Lake Huron, and proposed that they be referred to as the 'Keewatin' series (Wilson 1965, p.304). The Lake of the Woods area is the type area for Keewatin metavolcanics. These have been dated by Stockwell at 2,550 million years. Lowdon (1961, p.56) stated: 'the K-Ar age obtained on the biotite is the approximate age of metamorphism and is a minimum for the Keewatin'.

Keewatin Assemblage

The stratigraphic term Keewatin has consequently been extended to cover nearly all severely deformed and altered volcanic and sedimentary rocks that occur in scattered troughs and basins throughout Northern Ontario, and that were thought to be the oldest strata of the particular region being mapped (Stockwell 1957).

Goodwin (1965) did a detailed study of the stratigraphic sections of the volcanic units in the western half of the Wabigoon Belt. Goodwin's study included Lawson's type Keewatin area. Goodwin's (1965, p.6-7) description of a 'Keewatin Assemblage' fits the Finlayson Lake Metavolcanic-Metasedimentary Belt, he stated:

> The Keewatin assemblage is of diverse composition. It contains a wide variety of volcanic and sedimentary rocks. Volcanic components range from basalt flows to rhyolite pyroclastics, and sedimentary components from coarse conglomerate, arkose, quartzite and breccia, to thin-bedded, fine-grained greywacke and shale. The region at large is characterized by widespread and locally abrupt, overlapping, interchanging and gradations between volcanics and sediments on the one hand and between different types of volcanics and of sediments on the other. This leads to the concept of the Keewatin assemblage as a mixture of volcanic and sedimentary materials deposited contemporaneously in diverse relationships, and, locally, in distinct alternations, a view cogently and accurately expressed by A.C. Lawson (1885, p.101-102).
>
> Despite the complexity of distribution, a discernible periodic, or cyclical arrangement of lithologic types is present. The lithologic parts of a cycle, arranged in ascending order, are (1) basic volcanics, (2) acid volcanics, and (3) sediments. Two such superimposed cycles are present in the west part of the region. In the centre and east parts only one cycle, the probable equivalent of the lower cycle to the west, together with substantial thicknesses of sediments in part equivalent to and in part younger than the volcanic rocks, are present.

The Stratigraphic Section

The four main stages in the evolution of the Finlayson Lake Archean (Early Precambrian) volcanic-sedimentary assemblage are illustrated in Figure 3. This belt, with its vertical to steeply inclined attitudes of the rocks, provides an excellent stratigraphic section through an Archean volcanic pile.

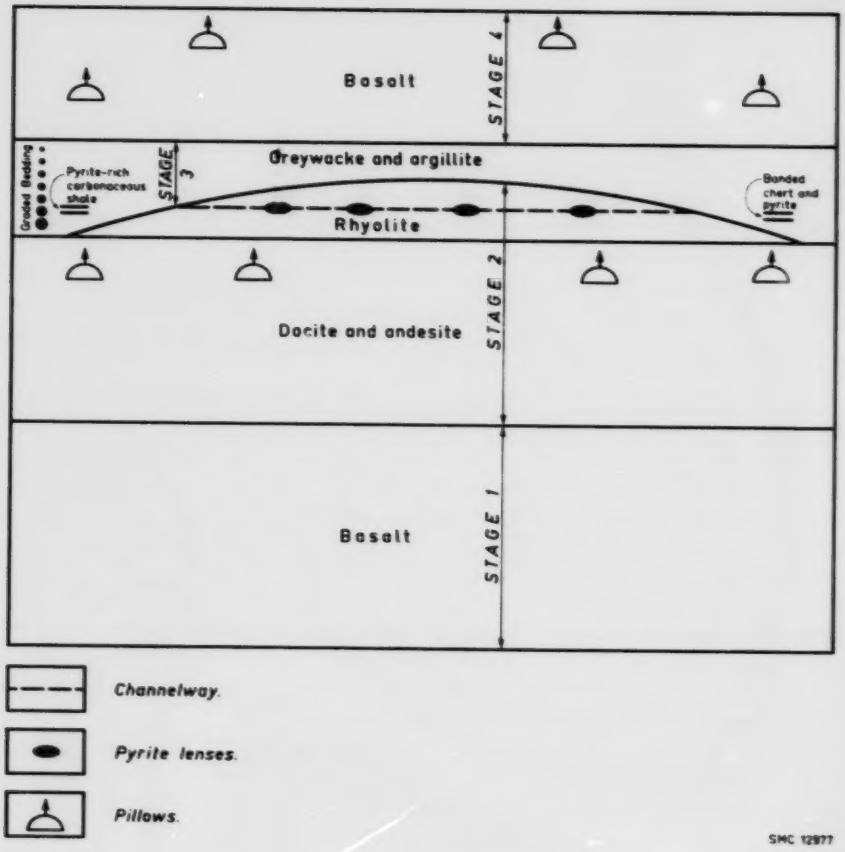

Figure 3–Schematic illustration of the four main stages in the evolution of the Finlayson Lake Early Precambrian Volcanic-Sedimentary Assemblage.

Finlayson Lake Area

The area consists of four distinct units which can be referred to as the lower mafic metavolcanic unit, the felsic metavolcanic unit, the metasedimentary unit, and the upper mafic metavolcanic unit. This sequence is comparable with Goodwin's description of a typical Archean greenstone assemblage in the Canadian Shield (1968, p.69). His typical volcanic sequence is made up of three stages; the Platform, Edifice, and Erosional Stages. A fourth stage, called by the author the Superimposed Stage, occurs in the Finlayson Lake Archean (Early Precambrian) assemblage.

The lower mafic metavolcanic unit forms the Platform Stage, and comprises mainly basalt volcanic flows. Pillows are rare in this portion; the environment of deposition is unknown. The mafic metavolcanics on the west side of the belt have maximum thickness of 8,000 feet (2,400 m). The reduction in thickness of the unit in the eastern part of the area is linked with intense shearing, and also with the intrusion of trondhjemite that contains numerous mafic metavolcanic inclusions.

The felsic metavolcanic unit representing the Edifice Stage is predominantly pyroclastic in origin. The lower half of this unit is a complex interfingering of mafic and felsic pyroclastic rock which appear to represent products of mutual explosive discharge from the same or neighbouring vents or fissures. Felsic tuff, pyroclastic breccia, and agglomerate are found in the upper part of the unit. Locally, pillowed flows (dacite) were noted. It is assumed that the felsic metavolcanic unit was produced largely by explosive activity. This unit has a maximum thickness of 3,000 feet (900 m).

The metasedimentary unit representing the Erosional Stage overlies the felsic metavolcanics, and is itself overlain by the upper mafic metavolcanics. Greywacke and argillite predominate, and were probably derived from felsic, and locally mafic, volcanic terrain. Graded bedding is well developed in the sedimentary rocks. The metasedimentary unit has a maximum thickness of 500 feet (150 m).

In the upper mafic metavolcanic unit representing the Superimposed Stage, pillowed basalts and andesites are exceedingly common. This stage is found overlying the metasediments and the felsic metavolcanic unit, and has a maximum thickness of 3,000 feet (900 m).

The presence of pillow structures in the lava flows, and of graded bedding in the metasediments implies a subaqueous environment upward in the succession from the upper half of the felsic metavolcanic unit. The metavolcanic assemblage apparently belongs to the basalt-andesite-rhyolite association (Turner and Verhoogen 1960).

The iron formation in the Finlayson Lake Belt has a maximum width of 40 feet (12 m) and is several hundred feet in length. They are intimately associated with pillowed andesite and basalt of the upper mafic metavolcanic unit, the pyroclastic rocks of the felsic metavolcanic unit and the greywacke and black carbonaceous shales of the metasedimentary unit. The associated rocks indicate a eugeosynclinal environment for the genesis of the iron formation, and a close relationship in time and space with volcanic activity (Gross 1965, p.91). The lack of primary textures, and association with metavolcanics and greywacke, indicate that the iron formation is the 'Algoma Type' of Gross (1965).

The persistent occurrence of massive pyrite with the felsic metavolcanic unit, pyrite-rich graphitic argillite, and chert in an eugeosynclinal association indicates a genetic relationship between pyrite and volcanism.

Felsic Intrusive Rocks

In the map-area, two major groups of felsic batholithic bodies differ spatially and compositionally from one another, and extend into adjacent areas. These granitic rocks have been termed, by the author, the Dashwa Lake Batholith and the Marmion Lake Batholith. The age relationship between the eastern Marmion Lake Batholith and the western Dashwa Lake Batholith is unknown, since they have not been recognized in contact, being separated everywhere by the Finlayson Lake Metavolcanic-Metasedimentary Belt. Since the Marmion Lake Batholith has been metamorphosed, and is sodic-rich, and the western batholith is not; the two batholiths are described separately, and placed into two distinct rock units.

Table 4 POTASSIUM ARGON DATES OF ROCKS FROM AREAS ADJACENT TO FINLAYSON LAKE.

Rock	K-Ar Age	Location of Samples	Reference
Granite[1]	Millions years 2,560	Northeast of Steeprock Lake	Goldich *et al.* 1961, p.52
Phyllite[2]	2,700	Diamond-drill hole at Strawhat Lake	Lepp and Goldich, 1964, p.1043
Paraschist[3]	2,480	Road-cut on Highway 11, 3 miles southeast of Atikokan	Lowdon *et al.* 1963, p.77

1. Sample No. KA—298B; determination by University of Minnesota.
2. Sample No. KA—294; determination by University of Minnesota.
3. Sample No. GSC-61-132; determination by Geological Survey of Canada.

Potassium-argon dates (Table 4) from nearby areas of Finlayson Lake, cluster around the mean date of the Kenoran Orogeny (2,490 million years) and indicate that this was the last major period of metamorphism, folding, and plutonic intrusions. The sedimentary, volcanic and granitic rock units in the area are therefore classified as Archean (Early Precambrian).

Kalliokoski (1968, p.1,199) stated that it remains to be proved whether the Kenoran dates should be interpreted to demonstrate the effects of the last of a series of orogenies, or to indicate that the Archean (Early Precambrian) rocks of the Superior Province have undergone major orogenic activity only once. On this matter, Jolliffe (1966, p.83) remarked that the geology around Steeprock Lake supplies clear evidence of two orogenies, widely separated in time; the older one is implicit in a pre-Steeprock granitic complex, and the younger in the deformation that involved the Steeprock Group.

Regarding the age of granitic rocks, those to the northeast of Steeprock Lake were termed 'Laurentian' in 1893 by Smith, as quoted by Shklanka (1968, p.46). Smith regarded the 'Steep Rock Series' as unconformably overlying the granitic and volcanic

rocks. Hicks (1950), regarded these granitic rocks as intrusive into the 'Steep Rock Series'.

On the other hand, Shklanka (1968, p.54) pointed out the following:

> By ascribing to a fault contact between the Steeprock Group and these granitic rocks, no firm evidence for a 'Laurentian' or 'pre-Steeprock' age can be cited.

In view of these difficulties, the writer assumed (with no evidence), that these granitic rocks were emplaced during the Kenoran Orogeny. Clearly, the problem merits more work to de done on it.

The granitic rocks west of Finlayson Lake have been regarded as Algoman (Kenoran) by Moore (1939, p.18) and Woolverton (1960, p.30). These rocks intrude the metavolcanics.

It can be stated that the granitic rocks are possibly of more than one age, and are younger than the Finlayson Lake Metavolcanic-Metasedimentary Belt.

MARMION LAKE BATHOLITH

The Marmion Lake granitic rocks are intrusive into the eastern margin of the Finlayson Lake Metavolcanic-Metasedimentary Belt, and have been assigned a Laurentian age by Moore (1939, p.9) and Hawley (1929, p.10). Shklanka (1968, p.54) however, stated the following:

> By ascribing to a fault contact between the Steeprock Group and these granitic rocks no firm evidence for a 'Laurentian' or 'pre-Steeprock' age can be cited. As such the conventional approach is followed by assigning this granitic body to emplacement during the Kenoran Orogeny.

Away from the contact zone, the granitic rocks are grey to white, and locally have reddish phases. Areas of epidotization give a yellow tint to the rocks. The rocks are massive to foliated, and medium grained to coarse grained. The proportion of biotite to hornblende is variable but biotite predominates in most places. In the vicinity of Turtle and Trap Bays, biotite trondhjemite is dominant in the north end of each bay, but hornblende trondhjemite is dominant at the south end.

In thin section, the typical leucocratic rock contains 55 percent sodic plagioclase, 35 percent strain-free quartz and 10 percent of biotite and/or hornblende. Potassium feldspar is sporadic, and occurs in minor amounts. Opaque oxides, apatite and sphene are common accessory minerals. Plagioclase has been considerably saussuritized, and biotite and hornblende have been partially altered to chlorite and epidote.

Shklanka (1968, p.85) referred to the granitic batholith as a metagranodiorite having lower greenschist facies mineralogy. Woolverton (1960, p.28) referring to the same batholith, stated that the plagioclase in this granite is generally saussuritized and may be itself a secondary feldspar; derived by soda metasomatism from a more basic plagioclase. Under the revised igneous rock classification recommended by a committee of the Ontario Division of Mines (Ayres 1972), the rock is called a trondhjemite, which is a light-coloured plutonic rock primarily composed of sodic plagioclase, quartz, sparse biotite, and little or no alkali feldspar (Gary *et al.* 1972, p.756).

Inclusions of metavolcanics are common in the Marmion Lake Batholith, and are abundant near the contact with the Finlayson Lake Belt. In the Hawk Bay area, the mafic

inclusions are stretched and oriented parallel to the granitic foliation. This indicates that the inclusions and the enclosing granitic rock underwent plastic flow (Kretz 1967, p.9).

Along the western margin of the batholith, foliation is well developed, and is parallel to the contact with the Finlayson Lake Belt and a pronounced northeast shearing. The rocks in the Messanda Lake, Trap, Turtle and Hawk Bays area are also strongly foliated and strike S60°E and dip vertical to 75°N.

A quartz-sericite schist occurs in areas of intense shearing. Microscopically, medium-grained quartz and sodic plagioclase grains are in a fine-grained matrix of sericite, carbonate and quartz. The quartz grains are fractured and highly strained and plagioclase is largely replaced by sericite and carbonate. This rock is difficult to distinguish from a schist derived from felsic metavolcanics. The rock cut on the river just south of Finlayson Lake is a good example of a shear zone.

A complex of felsic intrusive rock, mafic metavolcanic inclusions, and metadiorite dikes was noted along the southeast contact of the Finlayson Lake Metavolcanic-Metasedimentary Belt. The felsic intrusive rock is a hybrid, hornblende-biotite trondhjemite. The ferromagnesium minerals have been altered to chlorite and epidote; only relict amphibole and biotite was noted. Thin sections show considerable textural and mineralogical variation. The mafic content is variable, and depends on the amount of assimilated metavolcanic material. In places it is difficult to tell where the hybrid trondhjemite ends and the mafic metavolcanic rock begins. One thin section shows 40 percent saussuritized plagioclase, 30 percent fractured and strained quartz and 30 percent chlorite, epidote and carbonate.

The trondhjemite has been extensively invaded by late metadiorite dikes, especially in the contact zone. The metadiorite dikes compose 10 percent of the outcrop in this zone and markedly decrease away from the contact.

A quartz porphyry-metadiorite dike-mafic volcanic complex was noticed within the Finlayson Lake Metavolcanic-Metasedimentary Belt in the area east of Copper Hook Lake. Quartz porphyry is the name given to a felsic intrusive rock characterized by the presence of numerous blue opalescent quartz eyes. The rock weathers white, and is medium to coarse-grained and locally, is fine grained. Woolverton (1960, p.29) stated:

> The characteristic blue opalescence of the quartz is seen in thin section to be due to countless minute cracks and strains, and to innumerable liquid and gaseous inclusions in some of which Brownian movement of minute gas bubbles in liquid can be detected.

These quartz eyes were noted locally to be elongated parallel to the trend of the regional foliation. This fact and the strained and fractured appearance of the quartz eyes suggest that they are metacrysts. The mafic dikes are also parallel to the northeast trend, and some have been highly sheared. The quartz porphyry also intrudes the metavolcanics locally as narrow dikes and sills. In places, the felsic intrusive has the appearance of a rhyolite, but grades into the medium-grained quartz porphyry and appears to be the result of one period of igneous intrusion.

Narrow dikes of pink granite, and pink and white pegmatite are present in many areas, particularly in those marginal to the Finlayson Lake Metavolcanic-Metasedimentary Belt. In Hawk Bay, pink granite dikes compose as much as five percent of the outcrop, and cut the foliation of the older trondhjemite. In Lizard Lake, pink pegmatite dikes are found with feldspar crystals up to four inches (10 cm) in size and cut the mafic inclusions. These dikes were too small in scale to place on the map.

DASHWA LAKE BATHOLITH

The eastern margin of the Dashwa Lake Batholith is intrusive into the Finlayson Lake Metavolcanic-Metasedimentary Belt. A potassium-argon age determination on biotite from this granite yielded a Kenoran age of 2,560 million years (Goldich *et al.* 1961, p.64) and establishes a probable Archean (Early Precambrian) age for the Finlayson Lake Metasedimentary-Metavolcanic Belt.

Away from the contact area, the granitic rocks are fresh, massive to foliated, medium to coarse grained, and may locally have a porphyritic feldspar phase. Feldspar phenocrysts, up to 3 inches (7.6 cm) in size, were noted on Dashwa Lake. The rocks are mostly pink, but range from white to pinkish grey to pink. These rocks have many lithologic phases, and may vary in composition and appearance over short distances. The granitic rocks range from biotite granite to quartz monzonite; contaminated porphyritic trondhjemite is exposed adjacent to the mafic metavolcanics. Biotite granite predominates, but hornblende granite is locally important. In thin section a typical medium-grained pink quartz monzonite contains 20 percent quartz, about 30 percent potassic feldspar, 40 to 50 percent oligoclase-andesine and 5 to 15 percent biotite and hornblende. The amount of mafic minerals varies in the rock and may compose 50 percent of the rock. Myrmekite is common along plagioclase grain boundaries which adjoin microcline grains. Accessory minerals include magnetite, sphene and apatite. Secondary chlorite, sericite and epidote are present. The rocks are relatively fresh except for slight sericitization of plagioclase and chloritization of biotite.

Epidote has been found throughout most of the batholith, filling fractures.

A foliation caused by the alignment of biotite and/or hornblende grains is well developed near the boundary with the Finlayson Lake Metasedimentary-Metavolcanic Belt and is essentially conformable in strike and dip with the foliation in the adjoining mafic metavolcanics. Foliation is also developed in the main mass of the batholith adjacent to shear zones or joints.

Exfoliation of the granitic rocks, the breaking or peeling-off of concentric shells from bare outer rock surfaces by the action of either physical or chemical forces (Gary *et al.* 1972, p.243) was noted by the writer.

Northeast trending jointing is well developed in this batholith, and was probably very influential during glaciation.

Four isolated lenticular rafts of mafic amphibolite were noted in the granitic host, three miles (4.8 km) northwest of the Finlayson Lake Metavolcanic-Metasedimentary Belt. These rafts are probably erosional remnants of a roof pendant in the granite. In thin section, the amphibolite comprises 85 percent hornblende, 10 percent plagioclase and 5 percent quartz. The plagioclase has been almost entirely altered to saussurite. Hornblende occurs almost to the practical exclusion of all other minerals in the amphibolite.

Numerous large to small angular metavolcanic inclusions (xenoliths) of medium- to coarse-grained, foliated to massive amphibolite have been found throughout the Dashwa Lake Batholith, except for the Serpent Lake area. Where the inclusions are absent, the granitic rock is pink. The inclusions are rotated so that the relict foliation varies in strike.

At the contact between the Dashwa Lake Batholith and the Finlayson Lake Metavolcanic-Metasedimentary Belt, the granite is usually strongly foliated and frequently has a border phase of porphyritic trondhjemite. This trondhjemite contains medium- to coarse-grained oligoclase-andesine and quartz phenocrysts in a fine-grained groundmass

of quartz, plagioclase, biotite, hornblende, chlorite, epidote, myrmekite, sphene and magnetite. The rock consists essentially of 60 percent plagioclase, 30 percent quartz and 10 percent of biotite and hornblende; potassic feldspar does not exceed 2 percent.

Trondhjemite has also been found in areas where metavolcanic inclusions are numerous. It has probably formed as a metasomatic phase of the biotite granite. The latter may have reacted with the mafic metavolcanic rock to become rich in soda.

Lit-par-lit injection gneiss and migmatite contact phases are common also along the contact between metavolcanic and granitic rocks.

Three types of granitic dikes intrude the Dashwa Lake Batholith. These are: (1) pink granite pegmatite; (2) pink to white, medium-grained leucogranite; (3) pink, fine-grained aplite. These dikes are numerous throughout the Dashwa Lake Batholith and cut the mafic metavolcanics in the contact region, and the mafic inclusions within the batholith. On the winter road, south of Crowrock Lake, a three-foot (0.9 m) wide pegmatite vein was found to have been cut by a medium-grained leucogranite dike. Aplite dikes exposed along the hydro-line east of Forsberg Lake were noted cutting across the foliation in the granite gneiss.

Mafic Intrusive Rocks

DIABASE DIKES

West-northwest trending diabase dikes were observed to intrude the rocks in the Finlayson Lake Metavolcanic-Metasedimentary Belt. Their age relative to the granitic masses is not known. The dikes range in width from 1½ feet to 50 feet (0.4 m to 15 m) and average 10 feet (3 m) in width. The rock found in the dikes is fine to medium grained, with lath-shaped feldspar crystals showing the typical diabasic texture. In thin section, the rock consists of labradorite, pyroxene, and minor amounts of magnetite and apatite with secondary chlorite, epidote and calcite. The diabase is reddish brown on weathered surfaces and black on fresh surfaces. Occasional porphyritic phases show rounded pyroxene phenocrysts and well developed laths of plagioclase set in a fine-grained matrix of plagioclase and pyroxene.

Parallel vertical joints, normal to the strike of the dike, are a characteristic feature of the diabase. It is possible that the dikes were emplaced in tension fractures opened up normal to the major axis of the regional folding.

LAMPROPHYRE

Many lamprophyre dikes were noted in the map-area, and strike approximately parallel to the northeast-trending foliation of the metasediments, metavolcanics, and the northeasterly trending lineaments. The dikes cut all the rocks in the Finlayson Lake Metavolcanic-Metasedimentary Belt, but are generally too small to show at map scale. They range from a few inches (10 cm) to a maximum of 10 feet (3 m) in width, but most are about 1 foot to 3 feet (0.3 to 0.9 m) wide. They are not observed cutting the felsic plutonic rocks, and therefore their age relative to the granitic masses is not known. These dikes are especially prominent along the lakeshore and islands of Finlayson Lake.

ODM9279

Photo 6–Lamprophyre dikes weathered below level of adjoining more resistant metavolcanics.

Lamprophyre is fine grained, massive and dark grey to black. With the single exception of a hornblende-biotite lamprophyre noted on the west shore of Finlayson Lake (*see* 'Fin-Lan Copper Mines Limited'), all the lamprophyre dikes observed contain biotite as conspicuous phenocrysts. The groundmass consists of plagioclase, mica, chlorite, and carbonate with traces of apatite and pyrite. The dikes have been altered to rocks rich in chlorite and carbonate, and as a result, they generally weather below the level of the adjoining more resistant rocks (Photo 6). A narrow lamprophyre dike on the small island east of Masuba Bay contains numerous rounded to angular inclusions of quartz; one of which is 8 inches (20 cm) in size.

Moore (1939, p.18) and Woolverton (1960, p.31) relate the lamprophyre dikes in the general area to the main period of Algoman intrusion. Shklanka (1968, p.41) stated that:

'Although their age is unknown they post-date regional metamorphism.'

The author identified feldspar from one of the dikes as andesine by X-ray diffraction. The writer considers that the lamprophyres are not metamorphosed because the plagioclase present is andesine, not albite; all metamorphosed rocks studied show albitization. The biotite lamprophyre is a kersantite (Williams *et al.* 1954, p.85).

ANDESITE

A few narrow aphanitic andesite dikes were noted cutting the sodic trondhjemite to the east and also metavolcanic and metasediments in the Finlayson Lake Belt. These andesitic dikes normally follow the pre-existing foliation in the rocks.

Cenozoic

Quaternary

PLEISTOCENE

Direction of Ice Movement

The Finlayson Lake area has been extensively glaciated. Glacial striae and chatter marks are common on the rock surfaces, and the direction of the striae varies from S30°W to S45°W. In some places, two sets of striations were noted. On the west shore of the small lake north of Copper Hook Lake, a set of striations striking S30°W were observed superimposed on an older set striking S15°E.

Glacially polished surfaces were noted on a few metavolcanic and granitic outcrops. Some of the outcrops, especially the islands and along the shore of Finlayson Lake, have typical roche moutonnée forms which show the gently sloping stoss side and steeper lee side.

Glacial fluting, that is the formation by glacial action of large, smooth, deep, gutter-like channels or furrows on the stoss side of a rocky hill obstructing the advances of the glacier (Gary *et al.* 1972, p.270) is prominent also in the immediate area of Finlayson Lake.

The glacial striae, chatter marks, fluting and roche moutonnée indicate that the last glacial advance into this area came from the northeast. Zoltai (1961, p.64) states that this movement originated in the Patricia region in late Wisconsin time.

Glacial Deposits

The glacial drift is relatively thin and rock outcrops are abundant with the following exceptions: (1) in the region west of the south end of Copper Hook Lake; (2) in the area north of Detach Lake; (3) in the region one mile (1.6 km) southwest of Hardtack Lake.

A terminal moraine is found south of Finlayson and Marmion Lakes, and is the most outstanding glacial feature of the area. This moraine has been named the Eagle-Finlayson Moraine, and has been traced with only minor interruptions for a distance of 180 miles (290 km), (Zoltai 1961, p.68; 1965, p.252). The moraine is a single ridge, and rises over 100 feet (30 m) above the surrounding country south of Finlayson Lake. The material is stratified sand, and gravel, and is capped by 2 feet (0.6 m) of unsorted sandy till. Large boulders are abundant on its surface. Many crossbedded kame deposits are found incorporated into the Eagle-Finlayson Moraine (Zoltai 1961, p.68). A probable example of this type of deposit is found in a large sand and gravel pit one mile (1.6 km) west of the Seine River Diversion (Photo 7). The terminal moraine, at the junction where the road turns south to Highway 622, is overlain by 6 feet (1.8 m) or

ODM9280

Photo 7–Crossbedded kame deposit west of Seine River Diversion.

more of compacted till which is capped by loose ablation till (Photo 8). The large outwash plain (Photo 9) associated with the moraine is overlain by a thin layer of till. Apparently this section of the moraine was overridden by a later glacier (Zoltai 1961, p.68). Zoltai (1965, p.266) stated that the Steep Rock Moraine, which was found south of the Eagle-Finlayson Moraine, was formed first, and then the ice withdrew, and became stationary along the site of the Eagle-Finlayson Moraine. Evidence indicates that glacial overriding of the latter-mentioned moraine and outwash plain took place. The possibility that the Eagle-Finlayson Moraine formed first merits further investigation.

ODM9261

Photo 8–Terminal moraine overlain by 6 feet (1.8 m) of compacted till.

ODM9262

Photo 9–The Eagle-Finlayson Terminal Moraine and the outwash plain found south of Finlayson Lake.

ODM9283

Photo 10–Layer of red and grey varved clay, east of Detach Lake.

Varved Clay

Varved clay was noted at two locations. The first location is at the south end of Finlayson Lake. The clay was found in the north bank of the Seine River under the Eagle-Finlayson Moraine, and also along the southeast shore of Finlayson Lake. Some pebbles and rare boulders occur in the varved clay. The varves are grey, and consist mainly of clay.

The second locality for varved clays is just east of Detach Lake. Here, a unique band of red and grey varved clay, 14 inches (35.6 cm) thick, occurs (Photo 10). Zoltai (1965, p.266) considered that the red clay was deposited in glacial Lake Agassiz. Rittenhouse (1934) postulated that red clay sediments, rich in ferric oxide and high in carbonates, were brought into the lake from a distant source to the east of the area. A possible source (Zoltai 1961, p.80) is an ice-marginal lake, Lake Kaministikwia, in which stiff, red clay was deposited. This lake drained to the west through the Kashabowie-Seine Spillway into Lake Agassiz.

Calcareous Concretions

Three distinctive types of calcareous concretions were encountered in the map-area. Each type will be described individually.

The concretions in Photo 11 were located on the lakeshore of Marmion Lake and along the road going north to Marmion Lake (*see* Map P.543, for exact location). These concretions had been dredged from the Falls Bay section of Steeprock Lake, and discharged here. Scott (1961) briefly described the varved clays of the Falls Bay area, and noted that concretions were often found in the lighter coloured varves.

Leggett and Bartley (1953, p.524), in a report on an engineering study of the

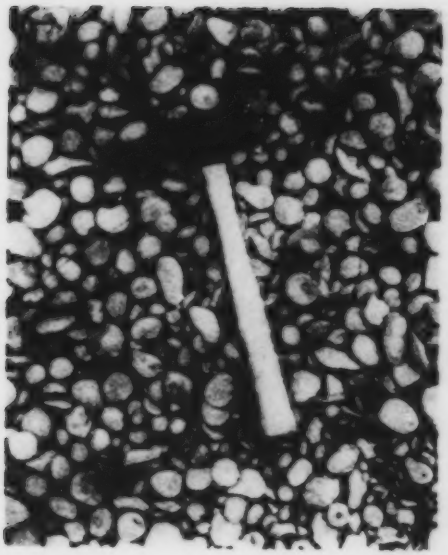

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Photo 11a–Calcareous concretions found on the south shore of Marmion Lake.

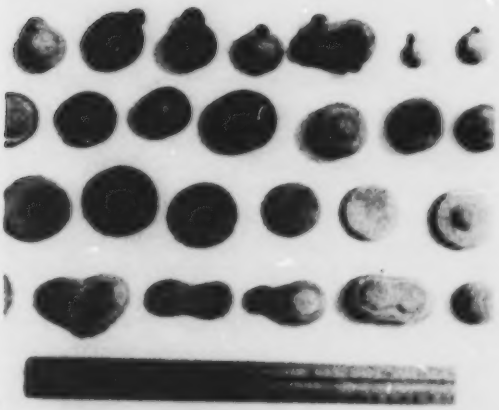


Photo 11b–Photo showing the different shapes and sizes of the calcareous concretions. Scale is 1 foot long and marked in inches.

ODM9285

ODM9286

Photo 12–Calcareous concretion showing a clay and silt layer.

glacial deposits of the Steeprock Lake, made the following statement:

> Another significant feature (which has been found elsewhere in glacial lake deposits) is the occurrence, regularly in the lower varved deposits, of flat lens-like calcareous concretions. They are always found in the light-coloured layers. These appear to have formed around nuclei and their presence suggests the existence, at the time of the deposition of the relevant varves, of water highly charged with calcium carbonate.

Leggett and Bartley (1953, p.532) stated further:

> Variations in particle-size distribution within the varves have also now been studied. It is yet too early to report upon these variations in detail but it can be recorded that, in the samples so far studied, there does not appear to be any general gradation, uniform or otherwise, from top to bottom of the varve.

The author collected a number of the calcareous concretions found in the vicinity of Caland's discharge pipe. These were sectioned by diamond saw and thin sections were made of the more interesting types. The following conclusions were made:

1) The calcareous concretions from the Fall Bay area of Steeprock Lake are not always found in the light-coloured layers. The clay layer of the varve was present in 90 percent of the concretions (Photo 12).
2) The concretions do not always form around a nucleus. Over one hundred concretions were sectioned, and only four of them showed evidence of nuclei. The bedding planes and laminae of the clay and silt layers continue uninterruptedly through the concretions.
3) Fifteen thin sections of the concretions were studied and in every one, faint to good, graded bedding was noted in the silt layer (Photo 12). The silt layer was normally found overlying the clay layer in the concretion. Also the silt part of the concretion is larger than the clay part. This is probably due to the fact that there is more calcium carbonate in the silt layer than the clay.
4) The concretions are the result of local cementation of the varve (clay and silt) by carbonate (Tarr 1935).

ODM9287

Photo 13a—Calcareous concretions cemented on glacially smoothed metavolcanics along the west shore of Copper Hook Lake.

Photo 13b—Photo to show the different shapes and sizes of these concretions.

ODM9288

The second type of calcareous concretions were those found cemented on glacially smooth bedrock along the west shore of Copper Hook Lake (Photo 13a, and b). These concretions have flat bottoms and rounded tops. Photo 13a, and b shows the bilateral forms (growing together of two or more concretions). The concretions also have glacial till cemented to them.

In thin section, the concretions are composed of silt made up of abundant quartz and calcite (30 percent) and of minor plagioclase, potassic feldspar, and mica. The silt is coarser at the base. The chemical composition of this type of concretion is presented in Table 3.

The following conclusions were reached by the author. A silt layer, followed by a thin deposit of till, was deposited on glacially smooth bedrock, probably in glacial Lake Agassiz. The concretions formed by local carbonate cementation. Finally, the host silt layer was washed away leaving the concretions.

The third type of calcareous concretions was found in a sand and gravel deposit on the north shore of the soutwest bay of Copper Hook Lake. They are quite gritty, and lack the normal concretionary forms. They are buff to grey in colour. In thin section, the concretions are of uniform texture, sand size and are composed of abundant quartz and calcite (35 percent) and minor plagioclase, potassic feldspar and chlorite. The chemical composition of this type of concretion is presented in Table 3. They have formed within the bedding planes in stratified sand (Photo 14a and b).

RECENT

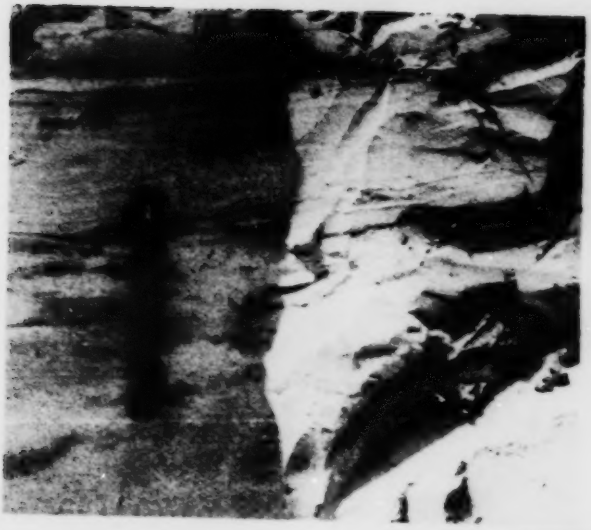
Recent sediments are swamp accumulations, river clay, silt and sand, and beach sand and gravel. The shores and islands of Finlayson Lake are characterized by sandy and pebbly beaches. The most southeasterly island in Finlayson Lake has three beach terraces. These resulted from the lowering of the lake, and represent three different water levels.

A peat deposit was noted north of the hydro line along the east bank of the Seine River. The deposit was 2 to 3 feet (0.6 to 0.9 m) thick and was overlain by 3 feet (0.9 m) of fine sand. This sand was probably deposited during the flooding of the Seine River Waterway in 1943.

Conchilites

Conchilites were noted in the Finlayson Lake area, and these have been described by Tanton (1944 and 1945) and Goodwin (1946). Below is a précis of these three papers.

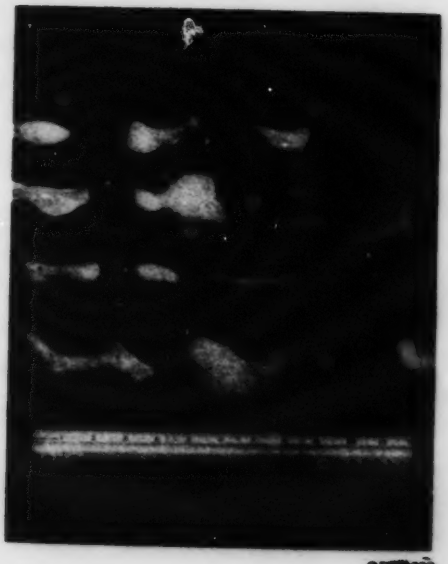
In September 1943 T.L. Tanton examined the newly exposed outcrops of the then modified Finlayson Lake. Tanton discovered small, bowl-shaped, rusty looking objects growing in an inverted position on the glacially smoothed surface of mineralized graphitic and sericite schists. Tanton called these objects conchilites; the name was derived from two Greek words meaning 'shell' and 'rock'. The conchilites were firmly attached around their edges, and when removed, were found to be filled with liquid varying in appearance from clear to turbid, and from colourless to greenish yellow and yellow-ochre. Tanton returned in 1944 to obtain samples of this liquid, but though he found many more shells the winter's frost had removed the liquid.



ODM9289

Photo 14a–Calcareous concretions formed along the bedding planes of stratified sand.

Photo 14b–Photo to show the different shapes and sizes of these concretions.



ODM9290

ODM9291

Photo 15a–Outer surface of large conchilite that was found on the property of Fin-Lan Copper Mines.

Photo 15b–Inner surface of large conchilite shown in Photo 15a.

ODM9292

Pebbles of granite, a rock foreign to this locality, were found cemented into some of the conchilite structures. This indicates that the conchilites were at one time under a till deposit.

The conchilites occur in the vicinity of mineralized outcrops and are distributed singly, in groups, or in clusters. individual conchilites range in diameter from 1 inch (2.5 cm) to 1 yard (0.9 m) and rise above the bedrock from less than 1 inch (2.5 cm) to more than 3 inches (7.6 cm). The majority of the specimens are shell-shaped, oval or circular with either smooth or irregularly scalloped outlines. A conchilite commonly shows fluted walls. The inner walls vary greatly being sometimes botryoidal, and, sometimes composed of glistening crystals of magnetite, covered with soft, powdery manganite. In addition, there are stalactitic and acicular linings.

The conchilites are identified as part of a cell structure that was growing by internal accretion on rock mineralized with iron and other sulphide minerals, at considerable depth (20 to 50 feet; 6 m to 9 m) under a fresh water lake. They grew after the Glacial period and are of Recent age.

Photos 15a and b illustrate the outer and inner surface of a large conchilite that was found on the property of Fin-Lan Copper Mines Limited. This property is an excellent 'hunting ground' for conchilites. The chemical composition of a single typical specimen is presented in Table 3. Goethite and probably limonite were the main constituents present. Minor magnetite was noted.

The present author noted that conchilites were found mainly in the vicinity of the iron formation and the pyrite showings. They are not only attached to these outcrops, but are also found cemented to sulphide-barren boulders of metavolcanics that are located beside the iron formation, and pyrite-rich outcrops and erratics.

Another interesting feature found on the property of Fin-Lan Copper Mines Limited in the neighbourhood of the iron formation and sulphide showings, is the occurrence of small yellowish brown to 'burnt chocolate' nodules. These nodules are found cemented to, and also rimming, and encrusting the boulders and pebbles in the old sand bottom. In one case, they were found covering the vertical face of a metavolcanic outcrop. The nodules on this face are in bands, and appear to indicate different water levels.

An unpublished report by the Mineral Research Branch, Ontario Division of Mines stated:

> These weathered nodules are made up of iron and manganese oxide minerals. Goethite was recognized and very minor magnetite. The goethite is only moderate in amount so the rest of the iron must be present as X-ray amorphous limonite. The manganese appears to be in part as pyrolusite (?) and probably X-ray amorphous wad.

The chemical composition of the nodules is given in Table 3 and indicates a high percentage of MnO. These nodules, and, perhaps the conchilites with the inner coating of manganite are similar to the lacustrine manganese-iron concretions described by Terasmae (1971).

Terasmae (1971, p.11) stated that the acidity of the surface water has a dominating influence on the leaching out of Mn and Fe from the rocks, minerals and soils. It appears that Fe and Mn were leached out of the iron formation, and that the acidity of the water was due to H_2SO_4; reflecting the large amount of pyrite in the area. Stilpnomelane was recognized in the iron formation, and could be the source of the manganese.

STRUCTURAL GEOLOGY

The Finlayson Lake Metavolcanic-Metasedimentary Belt appears to fit the picture of the typical Keewatin-type greenstone belt. It is isoclinally folded, and is downfolded between, and intruded by, two granitic masses of possible different ages. The large syncline and prominent northeast-trending lineaments in the area are all parallel to the axis of the Finlayson Lake Metavolcanic-Metasedimentary Belt. The northeast-trending lineaments on the west side of the Finlayson Lake Belt are faintly arcuate; this may have been caused by the intruding granitic rocks.

Primary Rock Structures

Primary features valuable for top determinations are rare in the area. Graded beds in the metagreywacke on the east side of the islands in the central part of Finlayson Lake are the only primary sedimentary features noted in the area. In this area, elongate pillow structures provide an indication of top direction in many volcanic flows. Pillow structures are found in both the felsic and the mafic volcanic rocks.

Schistosity

A marked schistosity is present in the metavolcanics, metasediments and felsic plutonic rocks. It is the result of low-grade regional metamorphism, and also is well developed along the shear zones. In the felsic volcanic rocks in the central part of the Finlayson Lake Belt and the plutonic rocks on the east side of the Finlayson Lake Belt, shearing has resulted in the development of quartz-sericite schist but in the mafic volcanic rocks shearing has resulted in the development of chlorite schist, chlorite-carbonate schist and amphibolitic schist.

The regional schistosity closely parallels the general strike of the strata and the major synclinal fold axis. The schistosity ranges in strike from N40° to 70°E, and the dip ranges from 90° to 70° northwest or southeast.

The regional foliation is locally disturbed near the contact with the granitic rocks, where the strike of the rock conforms to the strike of the contact of the intrusive rocks, and also in the area of crossfolding where the schistosity varies from its usual trend.

Gneissosity

Gneissosity is best observed in the granitic rocks and is the result of contact metamorphic effects. The attitudes of gneissosity mainly follow the granitic-volcanic rock contact. Most dips are steep. In the west part of the area, some distance from the granitic-volcanic rock contact, gneissosity is rarely seen.

Lineation

Rodding, the development of pencil-shaped structures of quartz and carbonate, was noted within the mafic metavolcanics near the dam site at Raft Lake. The rodding plunges at 15° with a bearing of N45°E.

Folding

MAJOR FOLDS

The Finlayson Lake Metavolcanic-Metasedimentary Belt trends northeasterly through Finlayson Lake. Top determinations based on graded bedding and pillow structures indicate that the Finlayson Lake Belt forms a syncline which is isoclinally folded. The symmetry of the Finlayson Lake Belt with the mafic metavolcanics on either side of it, and the felsic metavolcanics, metasediments, and mafic metavolcanics in the inner zone, is also indicative of a large fold. This major fold is an extension of Shklanka's (1968, p.67) Barr Lake Syncline which he outlined south of the map-area.

On the west side of Finlayson Lake, a minor northwesterly trending synform is superimposed on the major syncline. Evidence of this cross-folding is seen in the sharp changes in the strike of the foliation of the rocks along the west central side of Finlayson Lake, from northeasterly through southwesterly to an east-west strike.

DRAG FOLDS

Many drag folds are in the lean iron formation. Woolverton (1960, p.19) stated the following:

> Moore and Maynard, in discussing complex folding of iron formations, suggest that crystallization of the silica-iron gel did not occur until the weight of overlying rocks pressed the water out, and accompanying heat caused the gel to crystallize; thus, before it was fully crystallized, the soft rock readily flowed and became highly contorted.

This type of soft-rock deformation does not help in deciphering structure.

Minor drag folds in the metasediments and metavolcanics along the lakeshore and islands of Finlayson Lake plunge steeply (45° to 75°) to the northeast, and are interpreted as plunging in conjunction with the major syncline (fold structure) in this vicinity. In the area of Copper Hook Lake, the drag fold axis changes orientation to N70°E with a vertical plunge.

On the northwest side of the Finlayson Lake Belt, the minor drag fold axes trend N65°-75°W and plunge vertically to S70°E. This may represent the axis of the small synform in that area.

Small-scale crenulations were noted in a few shear zones. These crenulations trend approximately N45°E and have an average plunge of N45°E. The shear zone cutting the east side of the Seine River Diversion has good examples of these crenulations.

Lineaments, Faults, Joints and Shear Zones

Many northeast and east-southeast-trending lineaments were noted on the aerial photographs of the area and are expressed on the ground as straight shorelines and as linear valleys, rivers and swamps. These lineaments may represent faults, joints or shear zones.

The northeast-trending lineaments in the map-area are parallel to the Steeprock Fault System (Parkinson 1962, p.93).

The author has noted northeast-trending zones of shearing, lamprophyre dikes, and quartz and ankerite veins in the central portion of the Finlayson Lake Metavolcanic-Metasedimentary Belt, and northeast-trending quartz veins and andesite dikes in the Marmion Lake Batholith, in the vicinity of the major northeast lineaments.

The pyrite deposits (*see* section on 'Economic Geology') are also found along these lineaments. In the Finlayson Lake Belt, the sheared rock, pyrite deposits, lamprophyre dikes, quartz and carbonate vein networks, and the prominent linear valleys indicate that the lineaments may have provided channelways for the migration of mineralizing solutions.

Shklanka (1968, p.84) feels that these shears have been reactivated and states that the lamprophyre dikes follow the pre-existing northeasterly shears.

Shklanka (1968, 1972) has outlined in the Steeprock Lake area, three major northeast-trending faults; the Rawn Lake, Bartley and Samuel Faults, as well as numerous minor parallel faults. These faults may continue into the Finlayson Lake area. Shklanka stated (1968, p.74) that left-lateral separations of 2.3 miles (3.7 km) and 1 mile (1.6 km) are indicated, respectively, for the Samuel and Bartley Faults; separation on the Rawn Lake Fault probably greatly exceeds these amounts as no direct correlation of rock units on either side of the fault can be made within the area mapped.

It is difficult to accurately trace these major faults into the Finlayson Lake area because of the following: 1) the faults of the Steeprock northeast system are concordant with the structural trend of the Finlayson Lake Belt and so no displacement of lithologies was observed; 2) the terminal moraine and outwash plain mask all topographical indications of the faults in the south of the map-area.

The map-area was included in an airborne magnetic survey flown by Spartan Air Services Limited in 1961 for the Ontario Division of Mines and the Geological Survey of Canada. The resulting Aeromagnetic Maps were issued in 1961 at a scale of 1 inch to 1 mile (1:63,360) (*see* ODM-GSC Aeromagnetic Maps 7090G and 7104G).

The most prominent feature noted is a small northeast-trending linear aeromagnetic anomaly. This feature can be traced for approximately sixty-five miles (104.6 km) and mainly follows straight shorelines, elongated lakes and gullies. This regional feature is in the approximate position of Shklanka's Bartley Fault (Shklanka 1968, p.60) and to the north, Woolverton's Redpaint Lake Shear Zone (Woolverton 1960, p.37). If the Lumby Lake Greenstone Belt to the north is the faulted continuation of the Finlayson Lake Belt, then Shklanka's interpretation that the Bartley Fault exhibits left-lateral separation is correct. This is the only positive evidence for regional strike faulting along the strong northeast lineaments.

Probably the best developed east-southeast lineaments, possibly representing joints, served to localize the diabase dikes in the belt.

Two minor fault sets were noted in the map-area. These are as follows:
1) A left-hand set, in which the individual faults strike N5°-45°E and dip vertically.

The displacement along the faults ranges from 8 inches (20 cm) to 6 feet (1.8 m) and average 1 foot (0.3 m).

2) A right-hand set, in which the individual faults strike N15°-25°W and dips vertically. The displacement along the faults ranges from 1½ feet (0.4 m) to 6 feet (1.8 m).

ECONOMIC GEOLOGY

There are four main types of mineral deposits in the Finlayson Lake area:

1) Gold-bearing quartz veins due to structural control along northeast-trending fractures and associated with sodic-rich granitic rocks of the Marmion Lake Batholith.
2) Massive pyrrhotite, nodular pyrite, and minor chalcopyrite associated with cherty iron formation.
3) Massive to locally banded pyrite deposits associated with uppermost felsic meta-volcanic unit in a well-differentiated Archean (Early Precambian) volcanic pile.
4) Disseminated molybdenite associated with a quartz vein and altered granitic rock in a shear zone.

Prospecting for gold within the area has been carried on since the 1890s. The shafts of five gold mines (Golden Winner, Hammond Reef, Jack Lake, Upper Seine and Plator Gralouise Mines) were noted in the Marmion Lake area. None were big producers; the most productive mine, the Upper Seine Gold Mine yielded gold worth $21,785 in 1942 (Tremblay 1942, p.21).

In 1943, the lowering of the lake level in Finlayson Lake exposed up to ½ a mile (0.8 km) of shoreline and islands that previously were below water. Numerous rusty sulphide zones, mostly associated with iron formation, were noted and attracted new interest in the area.

The property descriptions are divided into two main groups. The first group includes the old gold properties and the second group consists of the more recent sulphide discoveries.

Description of Properties and Occurrences

OLDER PROPERTIES

Most of the gold properties described occur in localities which have been completely altered by the flooding of Marmion Lake. This, plus the fact that most of the properties were worked over seventy years ago, made it impossible to locate some of the exploration trenches, pits and shafts. For this reason, many of the old property descriptions are liberally quoted by the author.

Bates Occurrence (2)[1]

In 1897, claim A166, no longer held, was the claim immediately west of claim A168 located on the southwest shore of Trap Bay.

Coleman (1898, p.132) reported:

> Mr. M.W. Bates owns A166. Here an ore body somewhat like the Hammond reef is being opened up. The band of quartz mixed with some green schist strikes about N35°E. The green rock becomes rusty on weathering, and the quartz, which is rather white, contains some pyrites, the whole being about 50 feet [15 m] wide at the crosscut. The deposit may prove to be high grade, but it may be worked profitably on a large scale.
>
> On an island belonging to the same location there is a vein four feet [1.2 m] wide, running parallel to the main reef but a few hundred feet [metres] to the southeast, the quartz containing a considerable amount of iron and copper pyrites. Eight chains [160.9 m] from the last, at the east end of the island, there is a well defined vein 5½ or 6 feet [1.6 or 1.8 m] wide containing white and rosy quartz with much copper pyrites. This vein has a good foot wall, but less perfect hanging wall.

This showing was not located by the field party, but a prominent northeast-trending lineament was noted on the aerial photograph of the area immediate to the prospect.

Big Six Prospect (3)

The Big Six Prospect is situated ¼ of a mile (0.4 km) southeast of the east end of Eye Lake. It was discovered in 1897 by J.S. Steele. The prospect consists of the former claims WR56, 57 and 58, and BG13 to 17 inclusive, and was owned by the Clearwater Gold Mining Company of Saginaw, Michigan.

Bow (1899, p.91) reported:

> The formation is eruptive granite of apparently two different ages, and green chloritic schists, hornblendic near the contacts. The granite has the appearance of that of the Sawbill country. There are several veins on the different locations. The main one is on the contact which passes through the centre of W.R.56 with a strike of N.12°E. . . . The vein is distinctly traceable, and has been stripped to a considerable extent for a distance of about 1,000 feet [300 m] north of the shaft, which is sunk on the vein near the centre of the location.
>
> The shaft is six by ten feet [1.8 by 3 m] in size and 80 feet [24 m] deep, sunk on the hanging wall, which dips nearly 90 degrees east. At the bottom a drift has been driven seven feet [2.1 m] south. At a depth of 25 feet [7.6 m] a cross-cut has been driven west 16 feet [4.9 m]. The vein at the surface consists of two branches at the shaft, about 20 feet [6 m] apart, aggregating eight or ten feet [2.4 or 3 m] of quartz. These come together north of the shaft, where the vein averages three or four feet [0.9 or 1.2 m] in width. The quartz is white, containing iron pyrites, galena and sphalerite. . . .
>
> East of the main vein at the bottom of the hill on the same location, a tunnel has been driven southwest 15 feet [45.7 m] on a 3½ foot [1.1 m] vein, which cut off sharply at the end with distinct evidence of faulting. West of the main vein in the greenstone, several felsite dikes containing a little quartz occur, scattered over a distance of 100 feet [30 m] or more. Shots have been put in on some of these, and stripping done at a number of points. East of

[1]Number in parentheses refers to property numbers shown on Maps 2297 and 2298, back pocket.

the main vein a small quartz vein 19 inches [48.3 cm] wide outcrops and is said to be traceable for 1,000 feet [300 m].

Bow, (1900, p.81) also reported:

Depth of main shaft, 100 feet [30 m], depth of first level 80 feet [24 m]; drifting north, 70 feet [21 m]; south, 30 feet [9 m]; crosscut, 10 feet [3 m] south of shaft; direction, west; length, 18 feet [5.5 m].

Gardiner in his (1939, p.10) report 'The Gold Deposits of the Atikokan Area, Ontario,' stated that:

Quartz veins are found in the mafic metavolcanics near the contact with an intrusive granitic batholith in discontinuous and irregularly located sheared zones of varying width.

This appears to be the case here.

Clearwater Occurrence (6)

The Clear Lake Prospect is approximately three-quarters of a mile (1.2 km) directly south of the large island in Bradshaw Lake. In 1898, the property consisted of claims BJ115, 116 and X785, 786, and 796 (no longer held). The owners and operators were the Clearwater Gold Mining Company; head office, Saginaw, Michigan. All mining activity was confined to claim X785. The location of this showing was taken from an old claim map found in the files of the Regional Geologist, Ontario Ministry of Natural Resources, Thunder Bay.

Carter (1901, p.106) reported:

. . . the work done is as follows: No. 1 shaft, depth, 144 feet [43.9 m]; size, 7 by 9 feet [2.1 by 2.7 m]; dip vertical for 60 feet [18 m], then gradually inclining to 80 degrees north. First level: depth, 82 feet [25.0 m]; southwest drift, 63 feet [19.2 m]; at the face, crosscuts southeast, 12 feet [3.7 m]; northwest, 9 feet [2.7 m]; north drift, 56 feet [17.1 m]; at 20 feet [6 m] in, crosscuts, east, 6 feet [1.8 m]; west, 6 feet [1.8 m]. No 2 shaft or incline shaft, situated 150 feet [46 m] east of No. 1 shaft: depth, 185 feet [56.4 m]; size, 6 by 9 feet [1.8 by 2.7 m]; inclined north, at top 60 degrees but gradually flattening to 32 degrees at bottom. There are no lateral workings. A pit 12 by 12 feet [3.7 by 3.7 m] in size was sunk 20 feet [6 m] deep on a body of quartz 90 feet [27 m] southwest of No. 1 shaft; and a tunnel driven 20 feet [6 m] north in the side hill, 60 feet [18 m] south from No. 1 shaft.

No. 2 shaft follows down the footwall of a true fissure vein, which is apparently quite separate from that in the No. 1 workings. Between walls of massive gray granite a wavy vein of quartz from a few inches [cm] to two feet [0.6 m] wide extends from top to bottom of the shaft, but at this depth at the time of my visit a fault had been struck cutting off the vein clean, the fault plane vertical with northwest and southeast strike.

In the other workings to the west, No. 1 shaft is sunk through a gneissoid zone filled with numerous quartz stringers and in the same way granite. The north drift at 82 feet [24.9 m] depth shows no quartz, but the southwest drift follows along a few stringers in the schist for 40 feet [12 m], when the quantity increases a little and at 53 feet [16.1 m] the drift breaks abruptly into a mass of quartz and schist 14 feet [4.3 m] wide running this 10 feet [3 m] farther. The quartz of both veins contains little or no sulphides.

This prospect was apparently closed in 1901. This showing is in the vicinity of the trending lineaments that cut through the Jack Lake Mine site.

Connolly Occurrence (7)

Moore (1939, p.33) described a gold occurrence on a small island just off the southwest side of the large island that is 1 mile (1.6 km) southeast of Raft Lake. The author was unable to locate this showing; probably owing to the flooding of Marmion Lake this deposit is under water.

A prominent lineament striking N30° to 50°E passes through the area.

The following description is from Moore (1939, p.33):

> The vein has been traced for 1,450 feet, [440 m] although in considerable stretches only stringers of quartz are visible. It strikes N20°E and runs into the lake at the north end. The vein, which consists of quartz and carbonate, lies in granite along streaks of sericite and chlorite schist, the latter indicating remnants of greenstone inclusions. The quartz, where solid, has a maximum width of 3 feet [0.9 m], but in one place stringers of quartz make up a zone 8 to 10 feet [2.4 to 3 m] wide. It is mineralized with pyrite, and one sample picked from the ore contained a speck of visible gold.

Golden Winner Mines (10)

The Golden Winner Mine was located 2½ miles (4 km) northeast of the north end of Sawbill Bay. Production amounted to 15 tons (13.6 tonnes) for a total value of $70 at the price of gold in 1900. The mine has been described by Carter (1901, p.105) as follows:

> This property consists of four 80-acre locations situated on a small lake 4 miles [6.4 km] northeast of Sawbill Lake and a mile and a half [2.4 km] east of the Bonheur-Sawbill road. The owners are The Duluth Mining Company; offices, Duluth, Minn., president, N.J. Upham. Operations were discontinued in October, 1900, after about a year and a half's work. A stamp mill has been erected close to the mine, the building being large enough to accommodate a 10-stamp plant, but at present the machinery consists of a 5-stamp Fraser and Chalmers battery, amalgamation plates, one Frue vanner, a Reliance crusher, a locomotive boiler and one steam engine. The water supply was drawn by gravity from a small pond in a swamp 700 feet [200 m] distant. From the rear of the mill and on a level with the crusher floor a trestle extends back 100 feet [30 m] to the shaft, along which the ore was trammed into the mill. Close to the shaft and head frame stands the hoist house containing a small vertical boiler, a 4 by 12-inch [10.2 by 30.5 cm] single cylinder hoist engine using ⅝-inch [1.5 cm] steel rope, and a duplex pump.
>
> The deposit as exposed down the shaft is a large body of chloritic schist interbanded with quartz lenses and stringers all more or less highly impregnated with iron pyrites and dipping about 45 degrees south. The underground workings being partially flooded, the following information and measurements were obtained from the late foreman, J. Marshall: Mining started in the spring of 1899, being then confined to surface explorations. Seven test pits were sunk on an 18-inch [45.7 cm] pay streak on the hanging wall at the surface, and a 150-foot crosscut stripped the deposit from wall to wall. In October of the same year underground development started, progressing steadily till the close-down a year later. The shaft is 62 feet [18.9 m] deep, size 8 by 8 feet [2.4 by 2.4 m]; timbered with a 20-foot [6 m] collar and having hoisting and ladderway compartments. First level: depth, 62 feet [18.9 m]; crosscuts, north, 15 feet [4.6 m]; south, 80 feet [24 m]. At 74 feet [22.6 m] south the hanging wall was struck and has been drifted on, east, 42 feet [12.8 m]; west, 38 feet [11.6 m]. One overhand stope level removed for the total length of this drift, and in west drift a second level, 20 feet [6 m] width of stopes, about 4 feet [1.2 m]. The south 80-foot [24 m] crosscut was widened for its length to 10 feet [3 m], and this with all other rock mined was put through the mill.
>
> The workings are about one-quarter mile [0.4 km] northeast of the lake on which the camps are situated.

The property has become completely overgrown by vegetation and the pits are filled with water and debris. The mill was still standing, and was found southwest of the open shaft by the author. The rocks from the dump area showed white quartz with brown ankerite and small chloritic inclusions. Samples of andesite dike material were noted.

A prominent lineament striking N25°E cuts through the mine site as does a 5-foot (1.5 m) wide quartz vein. A grab sample from this quartz vein was assayed by the Mineral Research Branch, Ontario Division of Mines and was found to grade 0.02 ounce gold per ton (0.68 g/t) and contained trace amounts of silver. The host rock is a well foliated epidotized tronhjemite.

Hawk Bay Occurrence (11)

The Hawk Bay occurrence is near the southern end of the point of land, ¼ of a mile (0.4 km) east of the largest island in the central part of Hawk Bay.

Coleman (1898, p.132) reported:

At the Hawk Eay mine, 324X, under the directorship of Mr. H.. . Wiley, we found Mr. W.A. Harvey as superintendent, who kindly took us around the property. Two shafts were sunk 432 feet [131.7 m] apart, one to 80 [24 m] the other to 90 feet [27 m]. At the bottom of the 80-foot [24 m] shaft we found the vein rather pinched, being not more than a foot [0.3 m] wide. The main vein on which the shafts are and a smaller parallel one, 125 feet [38.1 m] to the west, are very irregular as traced in the surface and are seen equally irregular below ground. The vein strikes about 25° and is nearly vertical in the upper part of the shaft. The quartz is rather white, and the country rock is a greenish gneiss with an east and west strike. The mine, which had 18 men at work in July, has since shut down.

Bow (1898, p.66-67) reported:

Less than half a day's journey up the river from the Sawbill is the Hawk Bay mine, which is on a small bay off the Seine river. A large amount of development work has been done on this property, but unfortunately the company has been disappointed in its expectations and on September 28 ceased work altogether. Nevertheless there is a good quartz vein running northeast and southwest which has been traced about two miles [1.2 km], in a formation of altered granite similar to that of the Sawbill and Hammond Reef. The vein is similar in appearance to the Sawbill also, but not so wide. There are two veins on the property; the other being close by to the west, but not traceable so far. Four shafts have been sunk on the main vein; two about 200 yards [180 m] apart on the Hawk Bay property, and two on the location to the north through which the vein runs. No. 2 shaft, which is six by eight feet [1.8 by 2.4 m] inside the timber, has been sunk to a depth of 122 feet [37.2 m] and five feet [1.5 m] of drifting done at the bottom. The vein averaged about two feet [0.6 m] in width. Mr. Wiley of the Sawbill, who is one of the chief promoters of the company, told me that the vein kept the same at the bottom but depreciated in value, hence the reason for the discontinuance of work. No. 1 shaft is about 75 feet [22.9 m] deep.

The Hawk Bay Occurrence was not located by the author's field party.

Hendry and Tilden Occurrence (12)

Former claim 325X, owned by Messrs. Hendry, Tilden and Company in 1897, lies to the northeast of the Hawk Bay Mine.

Coleman (1896, p.75-76) reported:

Finlayson Lake Area

We examined 325X, which is said to be an extension of 324X on which the Hawk Mine is placed. At that time there had been no development, and there was no one to be seen in the neighbourhood. We found a well defined fissure vein a foot or two feet [0.3 to 6.6 m] wide, and followed it for a quarter of a mile [0.4 km]. The vein had a strike of 15° to 25° east of north, while the country rock, a greyish granitoid gneiss generally of the protogine type, though partly flesh-coloured, has a well marked foliation with a strike of 130° east of north. The quartz looks well, is rusty and contains some carbonate and copper pyrites. Here also a little green schist is mixed with the quartz or lies beside it. This vein impressed me more favourably than any other in the region.

Since our visit these two locations have attracted considerable attention, and it is stated are now being worked with very good prospects. They were reported upon by Mr. J.H. Chewett of Toronto, who speaks very favourably of them. Assays made of samples chosen carefully so as to give a true average of the vein showed gold to the extent of $21 per ton. As Mr. Chewett estimates the cost of mining and milling at about $6 per ton, there seems to be a good margin of profit.

Coleman (1898, p.132) reported:

Here Mr. E. Giessen as superintendent with 11 men was sinking a shaft on a vein running north 30° east and having a width on the average of about 2½ feet [0.76 m]. The quartz, which was very like that of 324X, is associated with green chlorite schist.

Bow (1898, p.67) stated:

On the adjoining location to the north a shaft has been sunk 60 to 70 feet [18 to 20 m], and south of this two or three hundred yards [180 or 270 m] another one 12 feet [3.7 m], in which the vein showed well.

This prospect was not located by the author's field party.

J.P. Manley (Sawbill Mine; Upper Seine Gold Mines Limited) (13)

The property of J.P. Manley (former Sawbill Mine and former Upper Seine Gold Mine) is situated on the east shore of the upper part of Sawbill Bay in Marmion Lake.

The property consisted of the patented claims 313X, 314X, 316X, 323X and the unpatented claims FF2659-60-61-62-63-64-65 and FF2730 (former).

HISTORY

The history of the property from 1895 to 1899 has been summarized by Gardiner (1939, p.30-31) who stated:

The property is first mentioned in an Ontario Government report in 1895, where it is remarked that the Wiley brothers had discovered a vein on Sawbill Lake. The Sawbill Lake Gold Mining Company, Limited, was incorporated in May 1896.

The Sawbill Lake Gold Mining Company owned mining locations 313X and 314X with the mine on 313X. Work was begun in April, 1895 and at the end of 1896 the main shaft had been sunk 145 feet [44.2 m]. At 60 feet [18 m] a level was cut south along the vein for 70 feet [21.3 m] and north 66 feet [20.1 m]. At 120 feet [37 m] a second level was run north 20 feet [6 m] and south 25 feet [7.6 m]. At this time supplies and machinery were brought in from Bonheur on the Canadian Pacific Railway, a distance of 33 miles [20.5 km].

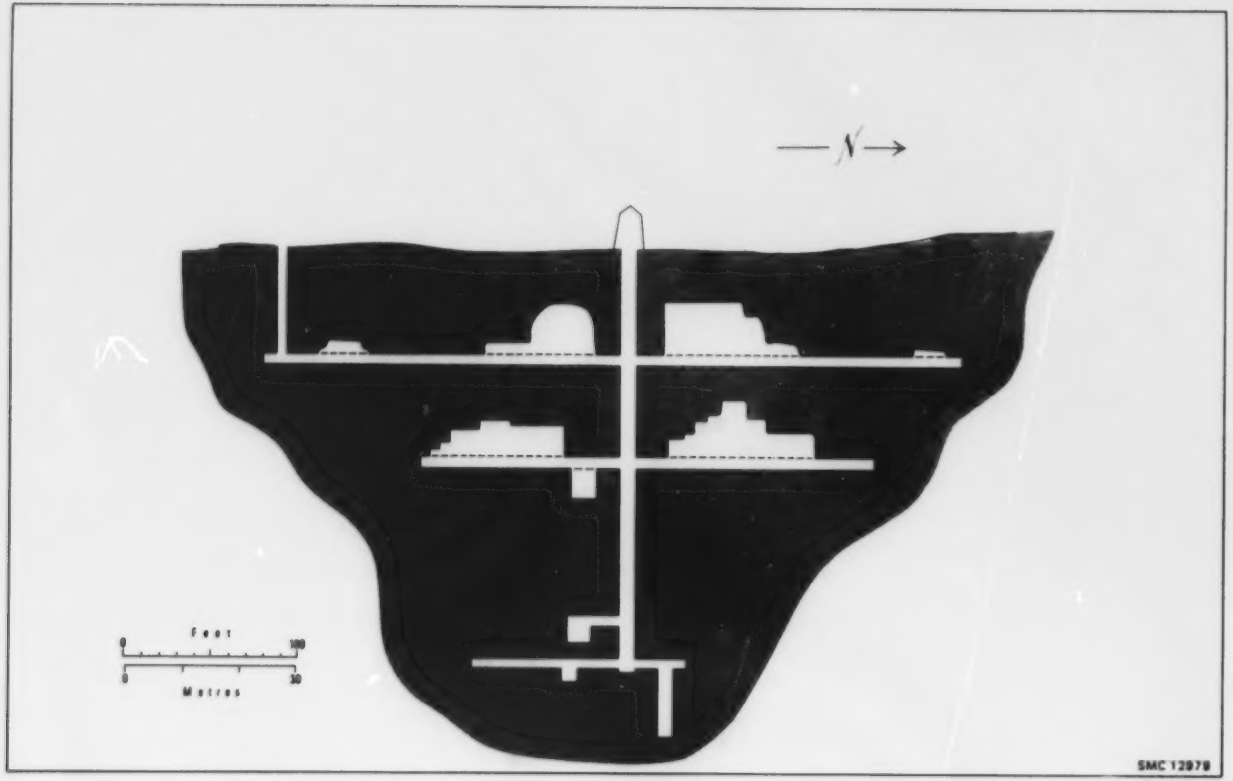


Figure 4–Vertical section of the underground workings at the Sawbill Mine (after Bow 1900, p.77).

In 1897 the shaft was deepened to 205 feet [62.5 m]. The 60-foot [18 m] level was extended south to a distance of 195 feet [59.4 m] from the shaft and north 177 feet [53.9 m]. An air shaft was sunk 186 feet [56.7 m] south of the main shaft on the same vein and connected with the 60-foot level [18 m]. At a depth of 120 feet [37 m] in the main shaft a level was driven south 117 feet [35.7 m] and north 135 feet [41.1 m]. On this level a sump 8 x 14 feet [2.4 x 4.3 m] and 15 feet [4.6 m] deep was sunk 15 feet [4.6 m] south of the shaft. On the first level a stope 40 feet [12 m] long and 28 feet [8.5 m] high was opened up in the south drift near the shaft. In the north drift some stoping was done also. On the second level and in the south drift a stope 40 feet [12 m] long and 18 feet [5.5 m] above the floor was opened and "Free gold is quite common all through it". A tramway was built some 550 feet [168 m] to the mill.

In 1898 the shaft was deepened to 230 feet [70 m] and the stopes enlarged considerably. Progress was impeded by a strong flow of water which was encountered on the lowest level.

In 1899 the shaft was deepened to 245 feet [74.7 m] and the first level was extended 13 feet [4.0 m] south and 13 feet [4.0 m] north. The second level was extended 15 feet [4.6 m] south. A sub-level was established at a depth of 220 feet [67 m] and was cut south 30 feet [9 m] with a 9-foot [2.7 m] winze at the end. A third level was cut at a depth of 243 feet [74.1 m] running north 30 feet [9 m] and south 85 feet [25.9 m]. A winze was sunk in the north drift of this level, 14 feet [4.2 m] from the shaft and 50 feet [15 m] deep. The Sawbill Mine produced 2,416 tons [2,191.3 tonnes] of ore between 1897 and 1899 valued at $8,982, or $3.72 per ton (gold at $20.00 an ounce).

The mine was closed down in the fall of 1899. The extent of the underground workings is shown on the accompanying section.

The following are quotes from "Mining in Ontario" contained in Ontario Department of Mines reports for 1940, 1941 and 1942.

Tower *et al.* (1940, p.214) reported:

Upper Seine Gold Mines, Limited, was incorporated in April, 1937, to succeed the Upper Seine Gold Syndicate . . .

The property consists of 11 claims, 560 acres [226.7 ha], located on Sawbill Lake in the Upper Seine area, district of Rainy River. It includes the old Sawbill mine, which produced gold in the nineties. . . .

During the first six months of 1938 the present operators did about 320 feet [97 m] of drifting on the third level, and suspended operations in June. The workings were allowed to fill with water. Operations were resumed in January, 1939, but no underground work was done. The mine was not dewatered. Some 600 feet [180 m] of surface trenching, a foot deep [0.3 m], was cut.

Tower *et al.* (1941, p,140) reported:

In 1940 underground operations were carried on from August 7 to December 31. The shaft was dewatered and retimbered to the 60-foot [18 m] level, where about 138 feet [217.6 m] of drifting was done . . .

The 50-ton amalgamation mill, purchased from Hudson-Patricia Gold Mines, Limited, and installed during 1939, was put into operation on October 1, 1940, and continued for the rest of the year, operating at an average daily rate of 19.85 tons [18.00 tonnes]. A total of 1,059 tons [960.5 tonnes] of ore was mined, and 1,072 tons [972.3 tonnes] were milled.

Tower *et al.* (1942, p.209-210) stated:

The present operators began work early in 1938 and carried on intermittently from that time until September 24, 1941, when both the mine and the mill were shut down. The following table shows the development work done during 1941 and the total when operations ceased:

Level	DRIFTS	
	1941	Total
	feet [metres]	feet [metres]
60-foot [6 m]	130 [39.6]	601 [183.2]
120-foot [36 m]	100 [30]	365 [111.3]
240-foot [73 m]	42 [12.8]	455 [138.7]

About 150 feet [46 m] of surface-trenching from 2 to 5 feet [0.6 to 1.5 m] in depth was done in 1941. A total of 1,825 tons [1,655.3 tonnes] of ore was mined. The mill treated 1,880 tons [1,705 tonnes].

Tremblay (1942, p.21) stated that the total production statistics for the mine for the year 1897 to 1899 and 1940 to 1941 was 5,368 tons, [4,868.9 tonnes] valued at $21,785.

The patented claims X313, X314 and X323 are presently owned by J.P. Manley.

GEOLOGY

A detailed geological map of the Sawbill and Hammond Reef mines was produced by Bruce (1925, insert facing page 32). The location of the shoreline had to be corrected on this map.

The Upper Seine Gold Mine is located in the Marmion Lake Batholith and is two miles east of the granite-greenstone contact zone.

Bruce (1925, p.32) stated:

> The geology of the Hammond Reef and Sawbill mines is very simple. The rock is granite with a few small dikes of dark-coloured rock. The granite is fairly fresh and much of it is high in quartz with a very little dark-coloured mineral. Other varieties have a considerable amount of biotite. In some places, there are what appear to be segregations of more basic, dark grey granitic rocks. Other areas of this kind may be almost completely digested inclusions of greenstone. Some of these are large enough to be shown on the accompanying map. Large zones of alteration occur in the granite. An altered biotitic variety consists of quartz, plagioclase almost completely changed to sericite, and biotite, which is quite green and in part completely chloritized. Any orthoclase that may have been present, is no longer recognizable. A pinkish variety of granite consists of quartz, acidic plagioclase, sericite, and a little magnetite.
>
> The dark-coloured dikes weather to rusty surfaces. A sample from one near the Sawbill mill is found under the microscope to consist chiefly of chlorite, calcite, and iron oxide. These dikes are later than the granite, and one in open-pit No. 2 cuts the quartz veins and so is decidedly later than the mineralization of the district.

SHOWINGS

The main or Sawbill vein, which is on 313X, has been traced 2,000 feet (600 m) with a strike of N25°E and, shows in the shaft, a nearly uniform dip of 75°E (Bow 1898, p.63).

Thomson (1936, unpublished report, p.7, Regional Geologist's Files, Ontario Ministry of Natural Resources, Thunder Bay) stated:

> The old Sawbill vein has been opened up for a length of about 1,000 feet [300 m]. The vein lies in rather fresh granite but occupies a strong fracture. The vein varies in width from

a few inches to 65 inches [165.1 cm], the average being about 3½ feet [1.07 m]. The quartz is white and waxy in appearance and contains little sulphide. In places small clusters of pyrite and chalcopyrite occur in the quartz.

When the writer visited the property on October 7th, a section of the vein 450 feet [137.2 m] in length had been channel sampled at 5-foot [1.5 m] long intervals, and gold values had been obtained over this whole length. According to an assay plan prepared by Mr. McClintock, three sections along this length gave the following gold values:

A southern section averages $5.45 across 35 inches [88.9 cm] over a length of 40 feet [12 m].

An intermediate section averages $10.30 across 30 inches [76 cm] over a length of 120 feet [36.6 m].

A northern section averages $11.00 across 48 inches [121.9 cm] over a length of 115 feet [35.0 m].

Values between these sections would average around $1.00. It should be noted that the surface of the vein had not been blasted off and the above samples might possibly be enriched by oxidized material although the surface of the quartz generally has a fresh appearance. A grab sample of quartz from different places along the vein taken by the writer assayed $14.00 per ton in gold.

The No. 1 and No. 2 shafts are on this vein. The vein apparently widens with depth, for Coleman (1896, p.76) has noted that it was 6-feet (1.8 m) wide at a depth of 49 feet (14.9 m), while Bow (1899, p.88) reported its width to be 6 feet (1.8 m) near the bottom of the shaft (230 feet; 70 m), and was told that it was 8 feet (2.4 m) wide at the very bottom.

A grab sample of the vein taken by the present author was found by the Mineral Research Branch, Ontario Division of Mines, to contain 0.29 ounce of gold per ton, 0.57 ounce of silver per ton and 0.47 percent copper.

About 350 feet (107 m) west of the main vein is the No. 2 or Sawbill Junior vein, which has been traced 1,000 feet (300 m) (Bow 1898, p.63).

Gardiner (1939, p.38) reported:

No. 2 Vein dips 80° east and varies in width from 2 to 15 inches [5.08 to 38.1 cm] with an average width of 12 inches [30.5 cm]. The vein is poorly mineralized with pyrite and chalcopyrite. Sampling of this vein is reported to have given rather low values.

About 1,000 feet [300 m] north of No. 1 shaft is a vein known as Williams Vein. This vein has been traced for about 200 feet [60 m] with an average width of two feet [0.6 m]. Former operators are reported to have taken high-grade ore from a pit some 25 feet [7.6 m] deep on this vein. Sampling of this vein is reported to have given some high values—one is reported as $36.00 over 28 inches [71.1 cm]. However, the values appear to be distributed erratically.

About 2,200 feet [670 m] north-west of the Williams Vein is a vein at the contact of a large greenstone remnant and the granite. It strikes north 30° east and is reported to have been traced some 900 feet [270 m] with an average width of 2 feet [0.6 m]. It is mineralized with galena and pyrite. This vein was worked by the Golden Fissure Gold Mining Company, Limited but after sinking a 60-foot [18 m] shaft the vein was abandoned. Sampling by the Upper Seine Gold Mines reported low values from this vein.

Three hundred feet [90 m] south of No. 1 vein is a sheared and altered mass of granite known as the "Reef". This is a continuation of the structure on the Hammond Reef property . . . The granite in this area has been extensively carbonated and sheared and quartz in stringers along a shear zone about 7 feet [2.1 m] wide and 400 feet [120 m] long has converted the zone into a stockwork. Surface sampling on the "Reef" and some 500 feet [150 m] of drilling in 5 diamond drill holes show that the shear zone carries low but uniform gold values averaging between $2.00 and $3.00.

New Golden Twins Prospect (14)

The New Golden Twins Prospect is situated on the northwest shore of Finlayson Lake, just west of Masuba Bay. In 1897, the property belonged to the Golden Twins Mining Company of London, England, and consisted of the former claims BC18 and X327 and 328.

Bow (1899, p.92) reported:

> The formation is green schist. The ore body is a large, irregular quartz vein from 10 to 25 or 30 feet [3 to 7.6 to 9 m] in width, with indefinite walls extending across the peninsula and on to the mainland, with a strike of north 35° east, and traceable for nearly 1,000 feet [300 m] with the greater portion exposed. Two shafts have been sunk on the vein on the peninsula 240 feet [73 m] apart, and at an elevation of 30 or 40 feet [9 to 12 m] above the water. No. 1 is five [1.5 m] by seven feet [2.1 m] in cross-section and 63 feet [19.2 m] deep. Being partially full of water it could not be entered, but the foremen informed me that at a depth of 47 feet [14.3 m] a cross-cut had been driven northwest 22 feet [6.7 m]. No. 2 shaft is of the same cross section and 16 feet [4.9 m] deep, sinking being continued.

Moore (1940, p.33) stated that the two old shafts are located on a quartz vein that runs northeast-southwest across a point of Keewatin greenstone. A felsite dike cut the greenstone in the vicinity of the vein.

Plator Gralouise Prospect (15)

Six patented claims FF5888, FF3704, FF3901 – FF3904 inclusive, had been held by Plator Gralouise Gold Mines Limited, and were forfeited on January 1, 1967. These claims occupy part of the west side of a large island in Marmion Lake, 2¼ miles (3.6 km) southeast of Raft Lake.

The following is a précis from Field (1954, p.79; and 1955, p.75):

> Plator Gralouise Gold Mines, Limited was incorporated in 1948 to succeed Plator Porcupine Gold Mines Limited.
>
> Mining operations on their six patented claims began on March 1, 1953 and were suspended in October, 1953. A two-compartment, vertical shaft was sunk to a depth of 275 feet [83.2 m] on claim FF3704, and levels were cut at 125 and 250 feet [38.1 m and 76 m]. It was dewatered and sampled in 1954. Fifteen diamond-drill holes, totalling 3,647 feet [1,111.6 m] were drilled from underground.

The headframe is situated on the northwest point of the island. A dump was noted north of the headframe, and a quartz vein was found north of the dump, and is probably partly covered by the dump. The vein is 12 to 18 inches (30.5 to 45.7 cm) wide, and carries small quantities of galena, pyrite and chalcopyrite, and strikes N35°E. The host rock is grey, massive to well foliated, trondhjemite that has been extensively epidotized. A grab sample of the quartz taken by the author was found by the Mineral Research Branch, Ontario Division of Mines to contain 0.04 ounce of gold per ton, 0.80 ounce of silver per ton and trace copper. A prominent lineament striking N35°E. passes through the mine site.

Finlayson Lake Area

Toronto and Western Occurrence No. 1 (18)

In 1897, claim 393X (no longer held) was the claim immediately west of the patented claim AL69, located southwest of Trap Bay.

Coleman (1898, p.131) stated:

> At the entrance to Sawbill lake on the Seine river is a camp of the Toronto and Western Company. The cook, in the absence of the manager, Mr. E.W. Lockman, informed me that they were developing two properties, 412X down the river and 393X up. The latter was visited, and proved to be a zone of shattered granite running north 25° west, containing numerous quartz stringers. The widest of these was 18 inches [45.7 cm], the average about a foot [0.3 m]. The quartz contains a little iron pyrites and sericite, and specks of free gold are found. The shattered zone extends over a bare hill, and on this three pits a few feet [metres] deep had been sunk, the extreme ones being 200 feet [60 m] apart. Three miners were at work sinking one of these pits.

This showing was not located in the field by the author.

Toronto and Western Occurrence No. 2 (19)

Claim 401X, no longer held, is a small island within, or just south of the group of small islands at the south end of Sawbill Bay (near the word Reservoir on Map 2298 in back pocket). This island may now be underwater.

Bow (1899, p.90) report:

> The Toronto and Western Mines Development Company, Limited, with head office at Toronto, have been sinking on several of their properties on the southern part of Sawbill Lake and vicinity for the past two summers. The only place visited was 401X, a small island of 2½ acres [1.01 ha] in the southern part of the lake. The formation is altered granite. A diorite dike 50 feet [15 m] wide and dipping 45 degrees north crosses the island in a direction of N. 53° W. A couple of smaller dikes occur on the island also. Small contact veins of quartz a few inches [cm] in width occur on both walls of the main dike. The main vein crosses the northwest side of the island with a strike of north 37° east and a dip 75 or 80 degrees east. Two shafts have been sunk 145 feet [44.2 m] apart on the vein. One was sunk 23 feet [7.0 m] and discontinued, and the other 50 feet [15 m]. The vein ranges from 10 or 12 inches [25.4 or 30.5 cm] to 2½ feet [0.76 m] in width.

B.W. Tripp (20)

The Tripp property consists of two patented claims FF2360 and FF2361 that are situated along the southern boundary of the map-area, half a mile (0.8 km) southwest of Long Paradise Lake. The claims were first worked in 1898, during this time a 45-foot (13.7 m) shaft was sunk on a narrow quartz vein. These claims were owned by Rebair Gold Mines, Limited (Gardiner 1939, p.45) in 1938, by Mr. Scheider of Thunder Bay in 1940, and by B.W. Tripp, 106 West Moodie Street, Thunder Bay, in 1970.

The following description is from an unsigned report taken from the Regional Geologist's Files, Ontario Ministry of Natural Resources, Thunder Bay.

The veins examined and sampled lie almost wholly on FF2361 starting at the southwest corner and running approximately N30°E to the north boundary and still northerly on to HP598.

There are three veins on the property, only two of which appear to be mineralized and it is these two which will be dealt with here. On only one of these (the most southerly) was any amount of sampling done.

The general geology of the area immediately adjacent to the veins consists of a granite with a few tongues and bands of greenstone still remaining in it. The greenstone increases to the west where, within a few hundred yards [metres] lies the approximate greenstone granite contact.

The south vein, the one with the greatest length on the sketch, lies mostly in the granite and where in the greenstone is narrow or lacking. It is mineralized throughout with pyrite, some chalcopyrite and possibly a little fine galena. The values appear to depend on the amount of the sulphides present and the sulphides themselves occur both disseminated and in concentrations along fractures.

The north vein is the longest vein on the property, extending from one side of FF2361 to the other and on to HP598. . . . This vein is joined by the south vein before it crosses the north boundary of the claim.

A second unsigned report dealing with the Tripp (*see* Regional Geologists Files, Ontario Ministry of Natural Resources, Thunder Bay) property stated:

North Vein

This vein, or series of closely parallel veins, was exposed in a series of nine trenches or pits, over a length of 660 feet [200 m]. Channel samples were taken from each of these exposures. No commercial values were obtained from this work. The sulphide mineralization was similar to that obtained from the South Vein, though not so heavy, and in addition, much galena was found in the vein exposed in the trench, fourth south-west from the most northerly exposure. . . . The North Vein, though mineralized (the mineralization extending five to six feet [1.5 to 1.8 m] into the granite on either wall) and having very strong walls, apparently does not carry gold except at its southwest end and there, in only small amounts over a short length.

South Vein

. . . results from this sampling, though values were good in individual samples, did not show up a shoot long enough or wide enough to be mined profitably.

From this sampling it was seen that the gold concentration is probably controlled by a fracture system and not by the sulphides. Although better values generally appear where the concentration of pyrite is greatest, the pyrite apparently does not contain the gold. . . . Apparently the gold occurs in the free state but too fine to be seen megascopically.

D.K. Burke, (Regional Geologists Files, Ontario Ministry of Natural Resources, Thunder Bay) in a report for Sylvanite Gold Mines, Limited described the south vein and stated:

The vein averages one foot [0.3 m] in width, strikes N30°E and dips 85° east. Along its developed length north and south of the shaft it is found to occur largely in granite porphyry except where it traverses an 80-foot [24 m] stretch of included greenstone. . . . The quartz, milky white in colour and carrying only sparse mineralization, follows a well defined persistent fracture. . . .

At the shaft collar the vein shows a width of one foot [0.3 m]. Reliable reports indicate that the vein widens to approximately 2.5 feet [0.76 m] at the shaft bottom. This is likely to be just a local bulge.

Channel sampling of the developed length of vein resulted in the outlining of two shoots. One of these, starting 69 feet [21.0 m] south of the shaft and continuing south, averaging 8.40 dwts (0.42 oz.) [11.9 g] /1.1′ [0.33 m] for 71′ [21.6 m]. The other, starting 27 feet [8.2 m] south of the shaft and running north, averaged 9.50 dwts. (0.475 oz. [13.44 g] /0.9′ [0.27 m] for 105′ [32.0 m]). Both of these shoots are below the level of economic mining.

The shaft and south vein were located during the field season. There is a strong northeast-trending lineament just to the west and the south vein appears to be a parallel fracture.

Ventures Claims Limited (Hammond Reef Mine; Rossmore Mines) (21)

The old Hammond Reef Mine is situated on the east shore of the upper part of Sawbill Bay in Marmion Lake, and is three quarters of a mile (1.2 km) southwest of the Upper Seine Gold Mine.

The property of the Hammond Reef originally consisted of nine claims, and was divided between two companies, the Hammond Gold Reef Mining Company, Limited, which owned the two claims 337X and 338X, and the Folger-Hammond Gold Reef Mines Company, Limited, which owned the remaining seven claims, 316X to 322X. In 1899, the two companies working the property amalgamated to form the Hammond Reef Consolidated Mining Company, Limited. The claims have been re-staked and are now listed as FF1258-FF1263, FF1267-FF1270, FF1463, FF1464, FF1554, FF1555. In the thirties, the property was renamed the Rossmore Mine and was owned by Copper Zinc Mines of Sudbury Limited. In 1970, the claims were owned by Ventures Claims Limited, 2100-7 King Street West, Toronto 1, Ontario.

GEOLOGY

Gardiner (1939, p.42-43) did a detailed study of the geology of the property and stated:

> The Hammond Reef lies directly to the south of the Upper Seine property and the geological setting is much the same as on the Upper Seine. The Hammond Reef lies almost wholly in granite with the Keewatin volcanics being represented by a few small inclusions of green schists. As before, the latest rocks on the property are the basic dikes.
>
> Microscopic examination of a section from one of these dikes shows it to be identical in character with those of the Upper Seine property. Approximately one-half of the rock is made up of chlorite, with iron carbonate and introduced quartz as important constituents also. Magnetite and leucoxene are present as accessories. These dikes may have been derived from a dike rock with a composition approaching that of an andesite.
>
> The greenstones are highly altered as are those of the Upper Seine property. They are strongly sheared and composed of chlorite, sericite, iron carbonate and quartz.
>
> The unaltered granite of the Hammond Reef is medium-grained in texture, high in quartz and deficient in ferro-magnesian constituents. An altered acidic feldspar is present also. Minor amounts of limonite, muscovite and sericite were found.
>
> There is a wide zone of much sheared and altered granite striking generally north 25° east across the property. This shear zone varies in width from 100 feet [30 m] to 500 feet [150 m] with an average width of approximately 200 feet [60 m]. The boundaries of this area are not sharply marked so that the shear zone grades gradually into the unaltered granite. Within this altered granite there are lenses of more intensely sheared rock and it is in such zones that mining operations were carried on. The fractures and sheared areas in the granite have been filled with quartz in stringers and veins and E.L. Bruce (1925, p.33) has noted that such quartz may form about ⅛ of the whole rock mass. There does not seem to be any general alignment to the fractures in the granite as they run in all directions, converting the whole mass into a stockwork. The fragments of granite in this altered zone are a rather coarse-grained greenish grey gneiss. The quartz of this granite is crushed and strained and the feldspars are

highly altered. The rock contains a large amount of iron carbonate, and muscovite is an important constituent in the altered granite.

The only mineralization noted by the writer was pyrite occurring in the quartz and the altered granite, and a little galena noticed in the quartz. Coleman (1898, p.130) has mentioned that sphalerite and magnetite are found also.

EXPLORATION WORK

A map under the name East Shore Gold Mines Property (Regional Geologist's Files, Ontario Ministry of Natural Resources, Thunder Bay) shows the above mentioned shear zone (locally termed a reef) as being approximately 1 mile (1.6 km) long and striking N45°E. It has been traced through the southwest corners of claims 317X, 338X, and 337X.

Gardiner (1939, p.40-2) summarizes the major part of the exploration work done on this property.

During 1897 an open cut (No. 3) 300 feet [90 m] long and 20 feet [6 m] deep was excavated on claim 337X. On the south side of this a large trench 97 feet [29.6 m] long, 40 feet [12 m] wide and 38 feet [11.6 m] deep was dug. On claim 338X a test shaft was sunk on the "reef" to a depth of 80 feet [24 m]. At 60 feet [18 m] depth a drift was driven east for 20 feet [6 m] and west for 17 feet [5.1 m]. Assays were reported to be considerably higher at the bottom of this shaft than on the surface. Much trenching was done on claims 316X and 317X and near the middle of the "reef" on 316X an open cut 47 feet [14.3 m] long, 9 feet [2.7 m] wide and 12 feet [3.6 m] deep was excavated. . . . A tramway ⅛ mile [0.1 m] long connected the open cut on 337X with the 10-stamp mill installed in October, 1897. A shorter tramway led from the inclined shaft to the main tramway. The only statistics available are that 977 tons [906 tonnes] of ore treated in the mill yielded $3,857, or an average of $3.95 per ton (gold at $20.00 an ounce).

In 1898 the work was all confined to open pits, the underground work being abandoned. The mine was closed down from March until August of this year but operations commenced again with an open pit 60 feet [18 m] long, 20 feet [6 m] wide and 10 to 20 feet deep [3 to 6 m], being excavated on claim 316X. An open cut 80 feet [24 m] long, 25 feet [7.6 m] wide and 15 feet [4.6 m] deep was excavated on claim 338X. During the summer several hundred tons [tonnes] of rock were blasted out of the large open cut on 337X but work was discontinued here when the ore zone was found to be too narrow to work.

In 1899 the two companies working the property amalgamated to form the Hammond Reef Consolidated Mining Company, Limited. The work during this year was largely confined to the building of a hydro-electric power plant by damming a small creek near the property, and increasing the mill to 40 stamps. A limited amount of trenching and stripping was done on the property.

The new mill was somewhat damaged by an electrical storm in October, 1900, after it had been running for 2 months. Operations were suspended as the grade of ore did not meet the expectations of the operators. Earlier in the year 1900 a shaft had been sunk 60 feet [18 m] from the bottom of the large quarry and three exploratory adits had been driven from 50 to 100 feet [15 to 30 m] into the "reef" and all had given low results.

Since 1900 no work had been done on the property.

Bow (1898, p.65) reported:

On the northern part of 337X there is a vein known as E vein, which runs nearly north and south and crosses over to 323X on the north. There is four or five hundred feet [120 or 150 m] of it on the Hammond property. It varies in width from three to three and a half feet [0.9 to 1.1 m]. The vein matter is white quartz, slightly charged with pyrites. A shaft six by eight feet [1.8 by 2.4 m] inside the timber has been sunk to a depth of 50 feet [15 m]. Two test

pits four and 12 feet [1.2 and 3.6 m] deep have been sunk also, and stripping has been done to the extent of 300 feet [90 m]. Almost in line with the open crosscut on the reef on 337X and to the west, is a quartz vein known as B vein. It runs east and west, and has been traced about 660 feet [200 m]. An incline seven by nine feet [2.1 by 2.7 m] in size has been sunk 127 feet [38.7 m] on it. This vein has maintained an almost constant dip of 22° from the surface to the bottom of the incline, which is something unusual; and it shows a width of from two to three feet [0.6 to 0.9 m].

Coleman (1898, p.130) added some more information:

There are three quartz veins associated with the reef, and on one near the stamp mill a shaft 60 feet [18 m] deep had been sunk. The quartz was not promising. B vein, near the open cut, dips about 40° towards the south, and apparently runs into the reef. It is about three feet [0.9 m] thick, carries some free gold and affords fairly good looking quartz. A new vein was being explored somewhat to the northwest of the reef, averaging at least a foot [0.3 m] in width, but in some places much wider. This vein is nearly vertical, shows some free gold and contains much galena. The quartz looks well, but is stated to be low grade.

Bow (1899, p.89) reported:

The present scene of operations is on the southern boundary of 338X, and partially on 316X adjoining, where an excavation 80 feet [24 m] in length, 25 feet [7.6 m] in width and 15 feet [4.6 m] in depth has been made and is being continued northward towards the mill on 338X. . . . A costean 30 feet [9 m] in length, 14 feet [4.26 m] in width and about 12 feet [3.7 m] in depth had been made north of the mill on 338X, and abandoned.

Hille (1932, p.3 report on Rossmore Mines, Regional Geologist's Files, Ontario Ministry of Natural Resources, Thunder Bay) reported on two veins not mentioned before:

'C' Vein: This is a very well defined true fissure vein from four to eight feet [1.2 to 2.4 m] wide, cropping out on 318X, for a considerable length, of which 400 feet [120 m] are uncovered. The strike is south 20 west, but its dip it not observable; it is very well mineralized with copper and iron pyrites, galena and here and there some blende. It is striking towards vein 'D' but its junction is not to be seen.

'D' Vein: Is a small vein from one or two feet [0.3 to 0.6 m] wide and runs parallel with vein 'A' (reef) cropping out near the lake at the west side of location 318X and can be seen for quite a distance striking north 25 east toward the lake. This vein was found while I was on the property but no work was done thereon. The ore shows copper and iron pyrites, and some galena.

A grab sample of quartz from the reef area was taken by the author, and was found by the Mineral Research Branch, Ontario Division of Mines, to contain 0.05 ounce of gold per ton and 0.71 ounce of silver per ton.

Gardiner (1939, p.44-5) summarized the sequence of events in the area:

The sequence of events appears to have been the same on both the Upper Seine and Hammond Reef properties. The volcanic rocks of Keewatin age were intruded by a granite, presumably Algoman in age. After the granite mass had solidified there was a disturbance which shattered the granite along a north-east south-west zone and the fractures formed were filled with quartz converting the zone into a stockwork. The basic dikes represent a late phase of igneous activity of the parent magma and are found cutting quartz veins, granite and volcanics.

MORE RECENT DEVELOPMENTS

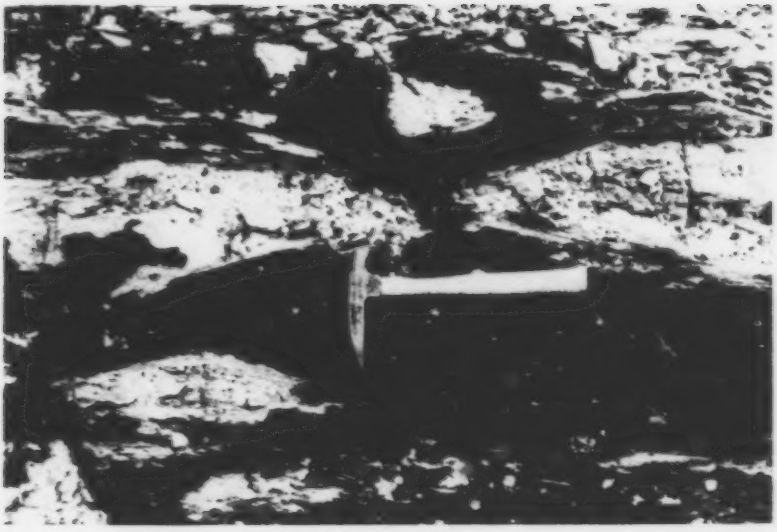
Mentor C. Addicks, Sr. (1)

In September of 1969, Mentor C. Addicks, Sr. staked twenty unpatented claims in the vicinity of Copper Hook Lake. These claims are numbered K22810 to K22817 inclusive and K45263 to K45274 inclusive. The area was originally held by Michael Wicheruk, prospector, who, in 1968, did extensive trenching and stripping. This work was done mainly on pyritic and pyrrhotitic iron formation, and thin interbeds of graphitic argillites; the location of the trenches can be seen on Map 2298 (back pocket).

Burrex Occurrence (4)

Burrex Mines Prospecting Syndicate held 31 unpatented claims (now forfeited) in the area northeast of Copper Hook Lake. In 1965 and 1966, the company did geological and self-induced potential surveys of the claims. Trenching was done on the north shore of Detach Lake in a medium-grained dioritic rock. Burr (1967), (*see* Regional Geologist's Files, Ontario Ministry of Natural Resources, Thunder Bay) states that mineralization (mainly 5 percent disseminated pyrrhotite) showed little copper, except for 'splashy' chalcopyrite along thin carbonate fractures. A grab sample, taken by the author, was found by the Mineral Research Branch, Ontario Division of Mines to contain only a trace of gold, silver, copper and nickel.

The main showing on these claims is found near the north end of the small pond northeast of Copper Hook Lake. Here, lenses (Photo 16) and elongated tabular masses of massive pyrite (Photo 17) are found parallel to the strike and dip of the foliation of the country rock (Figure 5). The main pyrite body varies from 1 to 14 feet (0.3 to 4.3 m) in width, averages about 6 feet (1.8 m) wide, and is at least 280 feet (85 m) long. Like the host rocks, the main pyrite body strikes northeast and dips vertically. A channel sample of the pyrite, taken by the author, was found by the Mineral Research Branch, Ontario Division of Mines, to contain 42.4 percent iron, and 50.4 percent sulfur. A grab sample of the pyrite taken by the author, was found by the Mineral



ODM8293

Photo 16–Pyrite lenses in altered host rock (felsic pyroclastic rock).

Research Branch, Ontario Division of Mines, to contain 0.16 ounce silver per ton, and a trace of gold, copper, and nickel.

The author did his Master's thesis on this pyrite deposit (Fenwick 1971), the abstract follows:

The Finlayson Lake pyrite deposit, in northwestern Ontario, is a massive to locally banded sulfide body which occurs in the uppermost felsic part of a well-differentiated Archaean volcanic pile, in an eugeosynclinal environment. The main pyrite lens varies from 1 to 14 feet [0.3 to 4.3 m] in width, and is at least 280 feet [8.5 m] long.

A hydrothermal alteration envelope surrounds the pyrite body. A comparison of the chemical analysis of the fresh rock to the altered felsic metavolcanic host rock indicated little change in SiO_2, Al_2O_3, TiO_2, P_2O_5, and MnO_2; addition of potassium, iron, water, and sulfur; outward migration of calcium, sodium, carbon dioxide and minor magnesium.

Narrow sulfur isotope ratios, in the pyrite, infer that the sulfur was derived from a uniform source, underwent little contamination during migration and has been fully homogenized. Therefore, the pyrite appears to be hydrothermal in origin.

The uniform content of the trace elements in the pyrite and also their similarity to the Steeprock pyrite and the Michipicoten pyrite, indicates a volcanic derivation for the pyrite's iron and sulfur.

A hydrothermal volcanic-exhalative origin for the pyrite is inferred by the presence of the alteration envelope, the narrow sulfur isotope ratios, the uniform content of trace elements, and the genetic relationship of the pyrite with the sulfide facies of iron formation and the rhyolitic stratigraphic sequence.

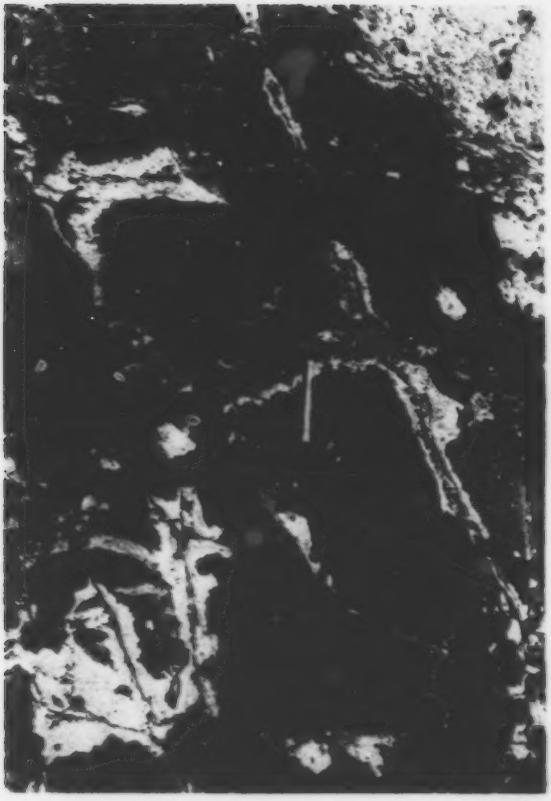


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Photo 17–Massive pyrite showing goethite-rich weathered surface.

The long dimension of the lenses in the pyrite deposit are parallel to the laminations in the pyroclastic host rock, and appears to be confined to a rhyolitic stratigraphic sequence, and, therefore can be called stratabound.

Tables can be found in the above mentioned thesis (*see* Fenwick 1971) that: 1) show the percentage gains and losses for the altered host rock near the pyrite compared to nearby relatively unaltered felsic volcanic rock; 2) compare the sulfur isotope data of the pyrite to a few of the better known type deposits (Sudbury Noranda, and a vein system); 3) compare the trace element concentration of the pyrite (Co, Ni, Ag, V, Cr, As, Pb, Ti, Se) with the trace element concentration from type deposits.

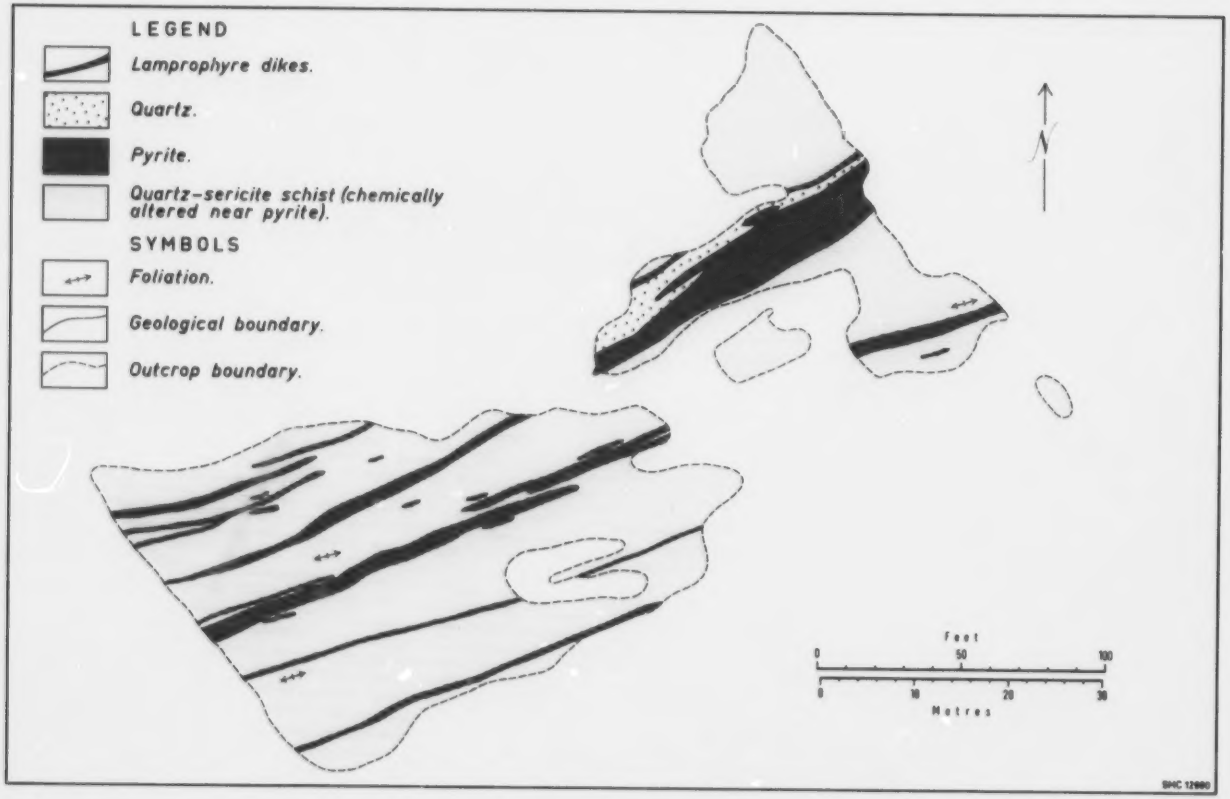


Figure 5–Geological map of the main pyrite showing at the Burrex Occurrence (4).

ODM9295

Photo 18--Canadian-Addicks main sulphide showing. Massive pyrrhotite in felsic to intermediate metavolcanics. Pyrite concretions are in pyrrhotite along fissures that cut the host rock and pyrrhotite.

ODM9296

Photo 19--Main sulphide showing at Canadian-Addicks property, close-up of Photo 18.

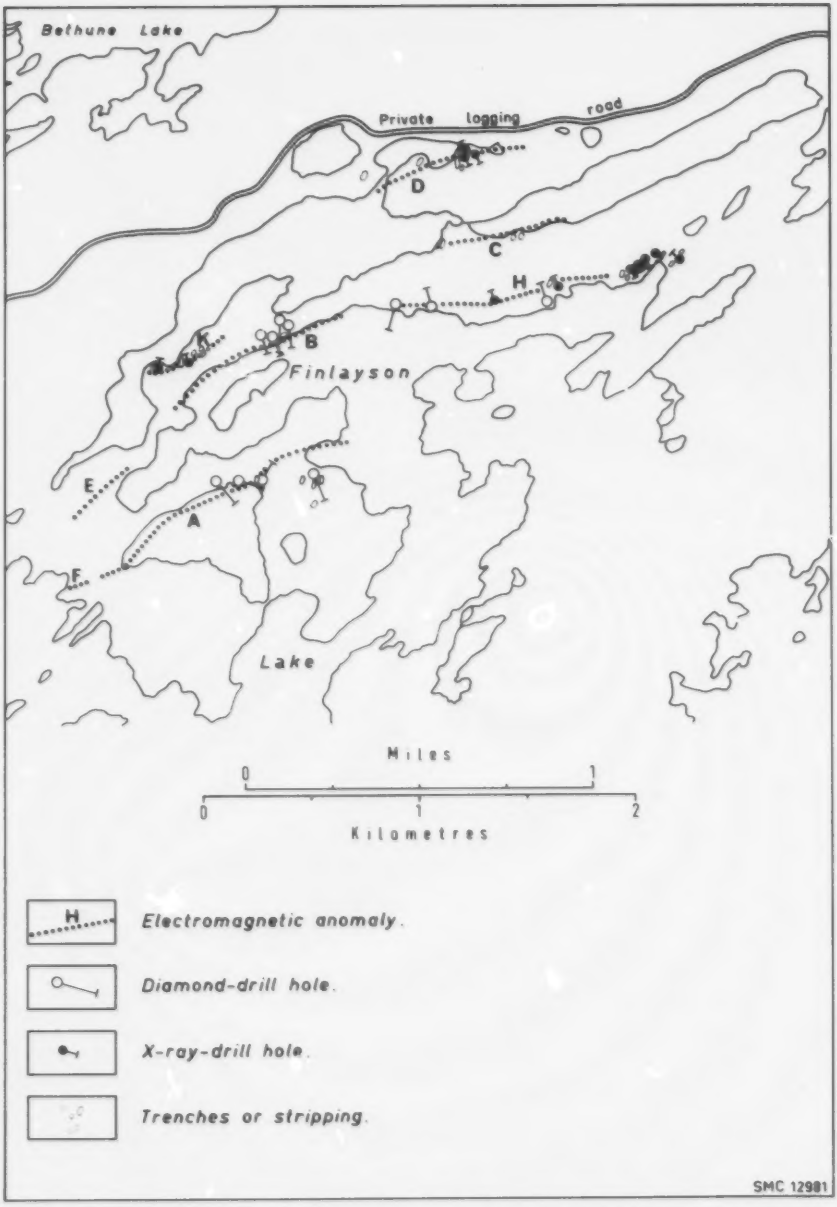


Figure 6–Approximate location of conductors and diamond-drill holes on the property of Canadian-Addicks Mining Corporation (5). (Information compiled from Regional Geologist's Files, Thunder Bay, Ontario Ministry of Natural Resources.)

Canadian-Addicks Mining Corporation (5)

The Canadian-Addicks Mining Corporation property consists of 34 unpatented mining claims numbered FF15656 to FF15665 inclusive, FF15667 to FF15672 inclusive, and FF15674 to FF15691 inclusive, which form a contiguous group just east of Gamik Point at the north end of Finlayson Lake. These claims, in 1967, were acquired from Mentor C. Addicks, Sr., and Mentor C. Addicks, Jr., who in turn had acquired the claims from two prospectors, David Thorsteinson and William Miron.

The main showing is just north of the large island that is 1¼ miles (2 km) northeast of Gamik Point. This sulphide deposit is in well-sheared intermediate metavolcanics, and is intimately associated with cherty iron formation (*see* section on 'Fin-Lan Copper Mines Limited'). The deposit strikes N70°E and dips vertically. Mineralization consists chiefly of massive pyrrhotite, massive and nodular pyrite, and minor chalcopyrite. It has been traced for over 50 feet (15 m) and may be up to 10 feet (3 m) wide. A grab sample of chalcopyrite-bearing pyrrhotite taken by E.G. Pye was found by the Mineral Research Branch, Ontario Division of Mines, to contain 1.77 percent copper and a trace of nickel. Photos 18 and 19 show the relationship between the pyrite concretions and the fissures. A similar deposit was found half a mile (0.8 km) to the southwest.

In 1966, Canadian-Addicks Mining Corporation conducted electromagnetic and magnetometer survey on their claims and outlined nine conductors. In 1969, 5,600 feet (1,700 m) of diamond drilling was done as well as trenching. Figure 6 shows the location of the conductors, diamond-drill holes and trenches.

Fin-Lan Copper Mines Limited (Nic-Cop Copper Occurrence) (8)

Fin-Lan Copper Mines Limited property has been worked on since 1955 and is located on the west shore of Finlayson Lake and is 2½ miles (4 km) from its south end. In 1955, the property was known as the Cranston Copper deposit. Assessment files with the Regional Geologist, Ontario Ministry of Natural Resources, Thunder Bay, indicate drilling of three diamond-drill holes (150 feet; 45.7 m) and testing by eleven trenches along the strike of the showing. In 1965, the property was restaked by Knut Kuhner, prospector, and was mapped geologically by J. Lill of M.E.M. Consultants Limited. They conducted electromagnetic and magnetometer surveys and drilled twelve diamond-drill holes (5,443 feet; 1,659.0 m) to test the conductors. Figure 7 shows the approximate location of the conductors and diamond-drill holes on the property. Kidd (geophysical report, 1966, Regional Geologists Files, Ontario Ministry of Natural Resources, Thunder Bay) stated:

> Conductors A,B,C,E,G, and H are known to have outcrops of iron and copper sulfides or rusty gossans along them or nearby. It is clear that these conductors are caused by sulfide zones.
>
> Conductors D and F do not outcrop. Their characteristics, however, are much like the others, and it is probable that these two conductors are also due to sulfides (p.1).
>
> In general terms, the widths of the conductive zones vary from 5 feet [1.5 m] to 35 feet [10.7 m]. Dips are consistently steep, and can be taken as close to vertical (p.5).

In 1969, Fin-Lan Copper Mines Limited acquired the property and did more trenching.

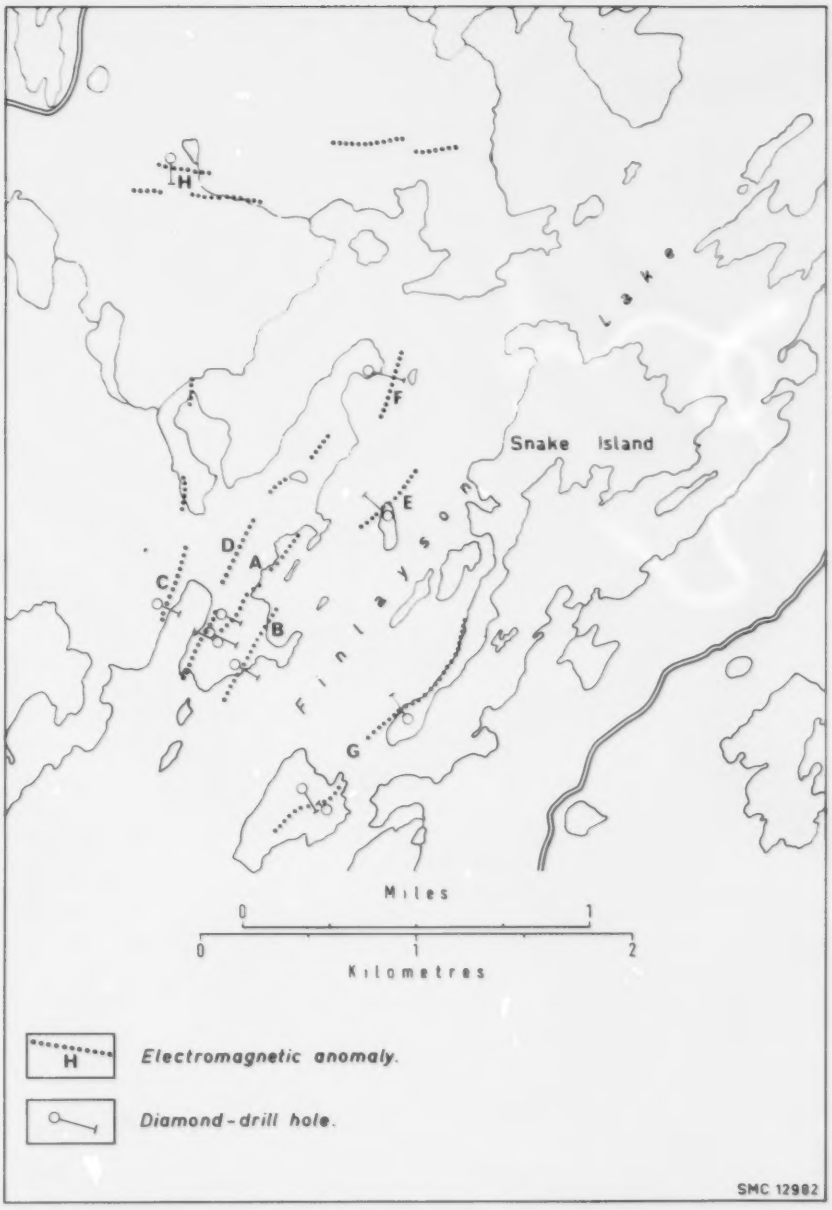


Figure 7–Approximate location of conductors and diamond-drill holes on the property of Fin-Lan Copper Mines Limited (8). (Information compiled from Regional Geologist's Files, Thunder Bay, Ontario Ministry of Natural Resources.)

GEOLOGY

The main sulphide showing trends approximately N30°E and dips vertically. It has been traced for a total distance of about 600 feet (180 m) by geological mapping on the surface; magnetometer and electromagnetic surveys indicate a total length of about 1,900 feet (580 m) (the northern extension is underwater). This tabular body is not straight, but is irregular in shape. The surrounding host rocks are mainly mafic to intermediate pillowed lavas and tuffs with minor amounts of intercalated metasediments. In immediate contact with the massive pyrrhotite are thin bands of fine-grained quartz-sericite-carbonate schist (metasediment?). Development work has indicated erratic sulphide mineralization along strike and in thickness. Widths of up to 16 feet (4.9 m) of massive sulphides were encountered. Mineralization consists chiefly of massive to disseminated pyrrhotite, nodular pyrite and minor chalcopyrite. An 8-foot (2.4 m) chip sample taken by E.G. Pye (*see* Ontario Division of Mines Summary of Field Work, 1965, p.65) was found by the Mineral Research Branch, Ontario Division of Mines to contain 0.42 percent copper and a trace of nickel. The sulphide showing when dry, is covered with a white fibrous coating of sulfate salts (melanterite; an alteration product of pyrite).

A well-banded siliceous sedimentary rock was noted on the footwall side of the pyrrhotite. It has the appearance of an iron formation but the chemical analysis (15 percent iron) in Table 2 indicates that it is too lean to be correctly termed a true iron formation (Gross 1965, p.83). A thin section indicates alternating bands of chert and fibrous amphibole (actinolite). This unit has been strongly folded and is not continuous but in sections. It varies in width along strike from 3 to 8 feet (0.9 to 2.4 m).

There appears to be a genetic association between the massive pyrrhotite and the cherty iron formation (?). This association is confirmed by Friedman (1959, p.269). In all locations where massive pyrrhotite occurs, chert inclusions are within the pyrrhotite; cherty iron formation is on strike with the pyrrhotite or intimately associated with it on the footwall side. Examples of this are the Canadian Addicks showing, Fin-Lan Copper main showing, and the showing on the southwest tip of Snake Island.

Friedman (1959, p.268) who studied a similar deposit stated:

> Many pyrrhotite and pyrrhotite-pyrite bodies, known to prospectors and geologists as 'dikes' are being discovered in the Canadian Shield as a result of intensive geophysical prospecting. . . .
>
> Magnetite is considered to have been precipitated in a marine environment. Deposition took place in an area of volcanic activity in which the clastic sediments were permeated by a gaseous network of H_2S. Locally precipitated iron hydroxide gels, and perhaps some magnetite, were converted to pyrite. At a post-geosynclinal orogenic stage in the history of the area pyrrhotite is considered to have formed at the expense of pyrite.

Kidd 1966 (1966, Regional Geologist's Files, Ontario Ministry of Natural Resources, Thunder Bay) in his geophysical report for Cyprus Exploration Corporation Limited confirms the above theory, quote:

> Conductors A,B,C,E,G, and H are known to have exposures of iron and copper sulfides or rusty gossans on them or very nearby. It is very likely that these conductors are caused by sulfide zones. They are also all magnetic, and this leads to conjecture that perhaps the sulfides result from the reconstitution of iron in the original magnetic state to the present pyrite and pyrrhotite state, and that perhaps there is still some magnetite left. The copper content has presumably been introduced later.

The chalcopyrite is locally found in pyrrhotite, pyrite and vein quartz as inclusions, and veinlets. Nowhere was it found to be of ore grade. Friedman (1959, p.269

stated that these types of pyrrhotite dikes' and pyrrhotite-pyrite deposits appear to be mostly devoid of base metal mineralization.

Found within the massive pyrrhotite are abundant and unique round ball-like bodies of pyrite. They vary from 1 mm up to 15 cm in size and average about 3 cm. These rounded pyrite bodies have been given many names in the literature. Woolverton (1960, p.25) called them concretions; Rose (1965, p.318) referred to them as nodules; Voytkevich *et al.* (1969) called them globules, and finally, Newhouse (1927, p.74) referred to them as balls. They will be referred to as concretions in this report.

These concretions are very similar in appearance to those that were found by Woolverton (1960, p.25) in graphitic argillite and those that were found by Antun (1967, p.219) in a strictly sedimentary environment (shale). The concretions on the Fin-Lan Copper Mines property are mainly found along fractures in the massive pyrrhotite, and are in a predominantly volcanic environment. The Fin-Lan Copper Mines property has been extensively trenched, and pyrite concretions are rarely found in place. As a result of this, it was not until the Canadian Addicks property was mapped, (Photo 18, 19) that an association between the fractures and the pyrite concretions was found. The pyrite concretions usually occur separately, but a number may coalesce along a fracture to form a definite layer of pyrite which may be several feet (metres) in extent. The fracture appears as a small seam in the concretion (Photo 20). The Mineral Research Branch, Ontario Division of Mines, identified by X-ray diffraction the mineral in the seam as siderite, and the concretion as pyrite. In Photo 21, the siderite can be seen to be along the main fracture that runs horizontally through the centre of the pyrrhotite slab. In this photo, some of the concretions form only on one side of the fracture; but in other areas they are not the same size on both sides of the fracture.

The concretions which are in the 3 centimetre range (Photo 22) show a radial structure (Antun 1967, p.219). The outer shells of these concretions are sometimes rimmed by small idiomorphic pyrite crystals. The larger concretions (Photo 23) that are greater than 3 cm in diameter, show concentric rings and cone-in-cone structure (Antun 1967, p.218). Woolverton (1960, p.25) stated that a few concretions show a similarity of patterns in the concentric rings, possibly indicating periods of growth in response to some external influence during diagenesis.

Inclusions and veinlets of quartz and carbonate are abundant in the concretions. Minor chalcopyrite was also noted as inclusions and veinlets.

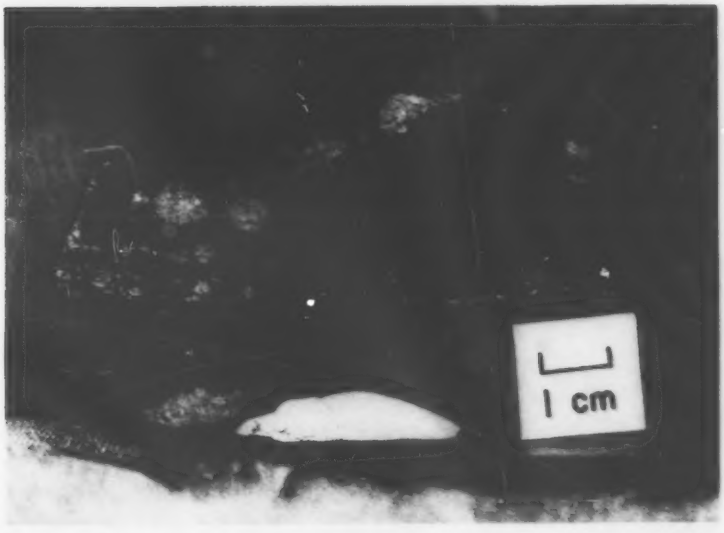
Voytkevich *et al.* (1969, p.943-p.944) described a similar sulphide occurrence in Siberia and stated:

> The hydrothermal pyrrhotite deposit of Medvezh'ye in the Eastern Sayan Mountains in Siberia was the subject of a study of the effect of microorganisms on the oxidation of pyrrhotite. Thiobacillus ferrooxidans, Th obacillus thioparus, and Thiobacillus denitrificans were discovered in oxidized pyrrhotite of the deposit. Since Thiobacillus denitrificans can develop under anaerobic conditions, it contributed to the generation of products of oxidation below the zone of oxidation. As the result of the activity of microorganisms, the sulfur in sulfides is oxidized, becoming part of sulfuric acid and iron sulfates. The thionic bacteria penetrated into pyrrhotite ore along microscopic fissures and pores. Under favorable conditions these microorganisms started developing around the centres of colonies forming spherical globules. Sulfuric acid produced by the activity of microorganisms reacted with pyrrhotite generating hydrogen sulfide, which, in turn, reacted with iron sulfate forming marcasite. Subsequently, marcasite transformed to pyrite.

This is an interesting concept; one can visualize in Photo 21, microorganisms penetrating the microfissures in the pyrrhotite slab and forming the pyrite globules. More work is needed to confirm this theory.

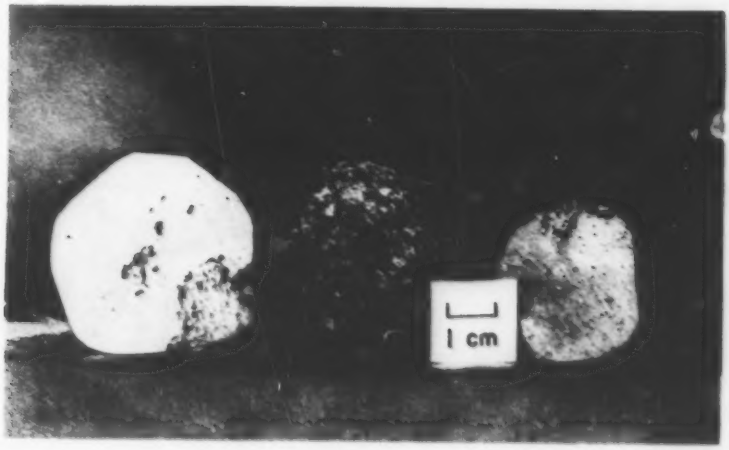
ODM9297

Photo 20–Pyrite concretion in massive pyrrhotite. Note the siderite seam cutting the concretion.



ODM9298

Photo 21–Pyrite concretions (globules) along microfissures in massive pyrrhotite. Siderite fills the open spaces along the fissure running east-west through centre of slab. Some concretions form only on one side of the fissure, others form on both sides, and are either equal or unequal in size.



ODM8299

Photo 22–Pyrite concretions showing internal radiating structure and inclusions of carbonate and quartz.

ODM8300

Photo 23–Pyrite concretion showing concentric rings. A cone-in-cone structure was noted in the outer ring.

A description of the old Nic-Cop Mines Limited occurrence can be found in the files of the Regional Geologist's office, Ontario Ministry of Natural Resources, Thunder Bay. It was written by Dr. E.G. Pye, and was taken from a personal communication with Steve Presunka, Ventures Limited. Mr. Presunka stated:

> The showing consists of pyrite and quartz with traces of chalcopyrite in greenstone (strike and dip N20°W, steeply east). This mineralization has been traced for 500 feet [150 m] across claim FF8184, with widths up to 3 feet [0.9 m]. Chalcopyrite is erratically distributed. Diamond drilling occurred in 1954 and 1955.

This showing was not located by the present author. Claim FF8184 was located on an old claim map and is in the vicinity of the area just north of the island in the large bay northwest of Snake Island. In 1971, this claim belonged to Fin-Lan Copper Mines Limited.

Freeborn Mining Syndicate (9)

The Freeborn Mining Syndicate owns four patented claims in the map-area, which are situated along the southern boundary and south of the east end of Eye Lake. A geological survey of the claims was conducted in 1947 and the conclusions were made that the general geology and the structural geology were not favourable for the formation of iron ore or gold deposition (unsigned report, July 21, 1950, Regional Geologist's Files, Ontario Ministry of Natural Resources, Thunder Bay).

Scheider Occurrence (16)

In 1952, the Scheider Occurrence (owner, F. Scheider, Atikokan, Ontario), consisted of 26 unpatented claims (since lapsed) which formed a block approximately 3½ miles (5.6 km) long by ½ mile (0.8 km) wide located along the southeast shore of Finlayson Lake.

Page (*see* Regional Geologist's Files, Ontario Ministry of Natural Resources, Thunder Bay) stated:

> Lenses of pyrite are located in a band of light coloured fissile sericite schist which strikes northeasterly and dips vertically. . . .
>
> Five exposures of massive pyrite are found along the 11,500 feet [3,500 m] length of the #1 zone. This zone is a section of fissile sericite schists lying roughly midway between the former lakeshore and the new shore developed since lowering of Finlayson Lake during the Steeprock diversion program. These bodies of pyrite have been designated as #1 to #5, starting at the extreme northeast end of the zone and progressing southwest.
>
> Exposure #1 consists of a low rounded ridge projecting through the clay of the former lake bottom. It is approximately six feet [1.8 m] wide and fifty feet [15 m] long. . . .
>
> Progressing southwesterly, some 5,000 feet [1,500 m] of low ground and heavily forested terrain is traversed before indications of pyrite are again encountered. At this point narrow discontinuous seams of pyritic material and float along the original lakeshore indicate the presence of sulphide material. A total of 6,500 feet [1,980 m] of ground was examined before the next mineralization was encountered. At this point, exposure #2, a lenticular form 25 feet [7.6 m] across at the widest point and 150 feet [46 m] long, is exposed within enclosing sericite

schist. This lens narrows rapidly at either end and contains a horse of waste some two feet [0.6 m] wide. Beyond the extremities of the lens there is little or no indication of pyrite mineralization. Some 200 feet [60 m] southerly from this exposure a diamond-drill hole shows 23 feet [7.0 m] (core length at 60 degrees) of approximately 65% pyrite. There is no surface indication of continuity between this and the #2 exposure just described.

Exposure #3 is located some 1,000 feet [300 m] southwesterly from #2. It consists of three feet [0.9 m] of schistose pyritic material on the edge of a clay filled depression. Core from a diamond drill hole shows poor grade pyrite across ten feet [3 m] of core length (at 70 degrees).

Proceeding a further 1,000 feet [300 m] southeasterly and across a small slough, exposure #4 was examined. This consists of a well developed lens of quite massive pyrite 20 feet by 130 feet [6 by 39.6 m]. It is to be noted that within ten feet [3 m] of either end little or no evidence of further continuity is to be seen.

On traversing another 1,500 feet [457 m] southwesterly over exposed rock surface no indication of mineralization was seen until exposure #5 was reached. At this point two feet [0.6 m] of what is probably the west wall of another lens is exposed along the east side of a low cliff. A sulfide content of 90% pyrite is apparent at this exposure. However fifteen feet [4.6 m] of core from a hole drilled beneath it shows no more than an average of 65% pyrite. To the south, clay overburden covers all extensions while for 75 feet [22.9 m] northerly, on strike, there is no indication of mineralization of any kind in the well exposed rock surface.

The lenses exposed in zone #1 have similar dimensions and are widely spaced along strike. Sufficient outcrops exist to preclude any suggestion that connecting structures exist but are obscured. There is nothing to indicate that subsurface lenses exist between the observed occurrences of pyrite. The discontinuous and lenticular nature of the mineralization in plan most probably persists in section.

Page's exposures, numbers 1, 2 and 3 were found by the author. These pyrite occurrences are lenticular, strike northeasterly, and are strata-bound within the platy felsic metavolcanic host rock. Locally, in the pyrite, there is fine banding, which is parallel to the general foliation trend of the area. On the footwall side (east side) of the pyrite lenses is a narrow band of graphitic argillite containing pyrite nodules. Roscoe (1971) in describing the Caribou sulphide deposit of the Bathurst-Newcastle area (Ordovician period) noted a similar relationship in which the footwall of the deposit is also a graphitic argillite. Roscoe (1971, p.1,135) stated:

> 2) The graphitic argillite . . . indicate a pause in silicic volcanic activity. 6) The Caribou deposit . . . probably formed on the sea floor by precipitation of sulfides from volcanic exhalative hydrothermal fluids.

These are the same conclusions made by the present author.

A strong northeast-trending lineament was noted on the aerial photograph passing through the area of the pyrite deposits. Gammon (1966, p.186) stated that shear zones have developed preferentially in the graphitic schists, because of their relative incompetence under applied stress. Perhaps this, plus the fact that the pyrite forms after a break in volcanic activity, and that this deposition break may be a zone of weakness, is the reason for the structural channelways in the vicinity of all pyrite deposits in the map-area.

Steep Rock Iron Mines Limited (17)

In 1971, eleven patented claims and four unpatented claims were held, by Steep Rock Mines Limited, along the southern boundary of the map-area. In 1961, two diamond-drill holes were drilled, for a total of 804 feet (245.1 m) on claim FF13370. Diorite and granodiorite were the only rock types noted in the drill logs (Regional Geologist's Files, Ontario Ministry of Natural Resources, Thunder Bay).

M. Wicheruk (Jack Lake Mine) (22)

The Jack Lake Mine is located on the southeast shore of Tyrell Lake (previously known as Jack Lake). The original owners were the Jack Lake Gold Mining Company, of Saginaw, Michigan. Work apparently ceased in 1902. Some of the ore mined was transported north to the Sawbill Mine, where the ore was milled, and a few gold bricks obtained (Hawley 1929, p.39). In 1961, Fidelity Mining Investments Limited drilled seven diamond-drill holes (2,294 feet; 699.2 m) on the property. The diamond-drill logs are on file with the Regional Geologist, Ontario Ministry of Natural Resources, Thunder Bay. In 1971, Michael Wicheruk had one claim on the property.

The following description is taken from Hawley (1929, p.38-p.39):

The vein on which the shaft was sunk lies in highly altered and schisted grey biotite granite and strikes N85°E. [The present author found the strike of the quartz vein and shear zone to be N45°E.] The schistose zone ranges from 10 to 15 feet [3 to 4.6 m] in width. About 100 feet [30 m] west from the shaft a sharp ravine suggests a fault, to the west of which the vein has been moved a few feet southward. On the east wall of this gorge a 1-foot [0.3 m] quartz vein is exposed for a height of 25 feet [7.6 m], lying between massive granite on the south and fissile sericite schist on the north, with a practically vertical dip. Across the ravine the vein narrows and lenses out about half way down the valley side. Here it lies between sheared granite on the south and a 6-foot [1.8 m] lens of green schist, which is highly impregnated with granite stringers. Along the strike to the west, at 3½ chains [70.4 m], an old pit was opened on 2 feet [0.6 m] of quartz.

To the east of the shaft, the vein has been covered by the dump. It is reported by Bow (1900, p.81) to consist of a 20-foot [6 m] reef, on one side of which occurs a quartz vein, 6 to 24 inches [15.2 to 61.0 cm] wide, carrying large quantities of galena, sphalerite, pyrite, chalcopyrite, and visible gold. "On the other side is 3½ feet [1.06 m] of poorer grade quartz with indefinite walls." Between these two lie siliceous schist and interlaminated lenses of quartz. Native gold is also reported in the vein in the shaft. The main vein here varies from 16 inches [40.6 cm] to 4 feet [1.2 m] wide and, with more quartz lenses and stringers interbanded with light-coloured chloritic schist, totals 8 feet [2.4 m].

"The shaft, 8 by 12 feet [2.4 by 3.7 m], is vertical for 140 feet [43 m], and from there to the bottom, at 192 feet [58.5 m], is inclined 80°S.E. At 102 feet [31.1 m] a drift was run 30 feet [9 m], and at 15 feet [4.5 m] a crosscut southeast for 16 feet [4.9 m]. At 187 feet [57.0 m] in the shaft a crosscut was run 9 feet [2.7 m] southeast. The vein is described as a true fissure vein which is faulted "in the face of the southwest drift at 102 feet [31.1 m], and in the shaft at 140 feet [43 m]." The fault plane is stated to dip 50° - 60°E., with a northerly strike, the direction of movement being along an incline of about 45 degrees with a horizontal component of about 27 feet [8.2 m]. The crosscut southeast from the bottom of the shaft was driven to tap the fault plane and the continuation of the vein. There is no record that the continuation of the vein was found. . . .

The quartz on the dump is white to glassy and shows abundant slickensided and striated surfaces along which shearing has occurred. These are often mineralized with pyrite, though in most of the quartz on the dump few sulphides are found. One specimen shows clear evidence that the quartz is a fracture filling, crystals of quartz growing out from the schistose and mineralized granite with a central zone filled with rusty-weathered carbonate. A sample was found containing, beside pyrite, some arsenopyrite.

Bow places emphasis on the andesite dikes (his term is 'greenstone' dikes), associated with the quartz veins in the Marmion Lake Batholith.

Bow (1900, p.81) in his description of the Jack Lake Mine stated:

The formation is altered granite. A band or dike of greenstone extends through the same with a strike of northeast. . . . It is a general rule . . . that all quartz veins in this altered granite formation are in or are associated with these greenstone dikes. . . . The greenstone is usually

schistose, especially next to the vein. Sometimes the whole dike is schistose, but it is the schistosity due to shearing and pressure, for wherever this feature occurs there is always distinct evidence of faulting, and the granite next to the schistose portion of the greenstone is more or less schistose, sometimes very markedly so. So that there is no doubt but all the bands of greenstone in this formation were originally massive, and of course of eruptive origin, and formed lines of weakness for the faulting, etc., of the country. These movements would, by shearing, grinding, etc., open up and otherwise render the zone of rock adjacent to the plane of faulting, or the dike, susceptible to vein-forming agencies.

The immediate area is cut by strong lineaments that strike approximately N45°E. The quartz veins, andesite dikes and shear zone at the mine site strike in the same direction. The fault in the gulley strikes north-south. A select sample of quartz from the dump area that showed a speck of visible gold was found by the Mineral Research Branch, Ontario Division of Mines, to contain 6.45 ounces of gold per ton and 5.36 ounces of silver per ton.

Wicheruk Occurrence (23)

A molybdenite occurrence was noted in the area of the east shore of Eye Lake. The molybdenite is found in a shear zone that strikes N20°E. The rocks in the shear zone are altered granitic rock and a quartz vein. This quartz vein, also strikes N20°E, pinches and swells, and has a maximum width of 3 feet (0.9 m).

An old adit, 102 feet (31.0 m) long, has been driven perpendicular to the strike of the shear zone. No information is available on the ownership of the adit. M. Wicheruk, prospector, worked the showing in 1968.

The molybdenite was found to be erratically disseminated in the shear zone. The Mineral Research Branch, Ontario Division of Mines found that two grab samples contain trace amounts of molybdenum, and that a third sample contains 0.42 percent molybdenum. Some high grade samples in quartz were uncovered in the dump area.

Recommendations for Prospectors

Massive pyrite has been noted along the east shore of Finlayson Lake. These pyrite bodies occur in the uppermost felsic part of a well-differentiated Archean (Early Precambrian) volcanic pile in an eugeosynclinal environment, and appear to be confined to a particular stratigraphic unit. Pyke and Middleton (1971) described a zone of non-mineralized massive pyrite that occurs between Kam-Kotia and Jameland Mines in the Kamiskotia area. This northeast-trending stratigraphic unit should be prospected for massive sulphides, because it has an environment that is similar to the sulphide ores of the Timmins, Noranda and Mattagami areas. Since this part of the lakeshore is old lake-bottom, and well covered with silt, etc., geophysical surveys are highly recommended in such an area.

Massive pyrrhotite deposits associated with cherty iron formation have received considerable attention in the map-area. Friedman (1959, p.269) stated that pyrrhotite dikes and pyrrhotite-pyrite deposits appear to be mostly devoid of base-metal mineralization. Moorehouse (1965, p.950), on the other hand stated:

Although not in themselves of commercial interest, some of these indigenous sulphides (pyritic and pyrrhotitic iron-formation) may have played a role in the localization of deposits of valuable sulphides, acting as precipitating agents or sources of sulphur in the presence of metal-bearing solutions. Where they have been caught up in later intrusions or involved in granitization, they may act as collectors of valuable metals and thus be resurrected in an enriched form.

Therefore, these occurrences deserve consideration.

Many gold showings were noted in the vicinity of the northeast-trending lineaments in the sodic-rich Marmion Lake Batholith. Many of these showings and lineaments require more work to be done on them.

The reasons why this district was not successful as a gold producer are outlined by Bruce (1925, p.1-2):

> Detailed examinations show that the failure to establish profitable gold mining in the region west of Lake Superior is due to a combination of circumstances. In many cases, the veins developed were too small or too low in gold content to merit the amount of time and money expended upon them, and proper advice to the operators would, if followed, have saved much loss. On many claims, the work was done in a haphazard way, and usually the installation of a mill was undertaken long before there was any need of it, or any reasonable grounds for believing that a mill would be necessary at all. As a result, the available funds were exhausted before the vein had been fairly tested. . . . Some mines apparently were making profits in a small way, but ambitious directors attempted to make them into large mines without regard to the character of the ore bodies or the amount of ore blocked out, and the result was disastrous. . . .
>
> In addition to the factors enumerated, much gold was no doubt stolen from some of the high-grade pockets, and there were also unavoidable losses, since methods of treatment of gold ores had not reached the perfection they now have. Cyanidation was only beginning to be used, and the modern method of fine grinding had not been thought of.

Gardiner (1939, p.47-48) has reached the following conclusions on the district:

> Most of the gold deposits in the Atikokan area can be classed as fissure vein deposits . . . the Upper Seine mine is characteristic of this type. Because of the lack of any considerable amount of fracturing before the veins were formed, the solutions were not able to penetrate far into the country rocks near the veins. At the Hammond Reef property, there has been considerable fracturing of the granite and consequently a large deposit of low grade ore has resulted. In spite of the immense tonnage available, the grade of the ore does not make the property attractive.
>
> All the deposits show an abundance of ferruginous carbonate which has replaced the country rocks considerably. The dark brown weathered outcrops may be seen in every case in the immediate vicinity of the veins.
>
> Although the veins carry fairly high values over short widths and lengths, the values are confined entirely to the veins and the county rock is barren in almost every case. . . . Bruce (1925, p.2) has commented on the lack of wall rock mineralization in this way:
>
> On the whole, the amount of replacement or impregnation of country rocks along the veins, even where they are in schistose greenstone, is not very great, and this seems to be the most unfavourable feature of the greater number of the veins seen. This fact, together with the discontinuous nature of the veins and erratic distribution of the values, on the whole, characterize the gold deposits in the vicinity of Atikokan.

Hawley (1929, p.31) stated that many of the gold deposits occur in the Laurentian granite and gneiss, often near inclusions of greenstone. Bow (1900, p.81), placed an emphasis on the andesite dikes (his term is greenstone dike) associated with the quartz veins in the Marmion Lake Batholith, and states that it is a general rule that all quartz veins in this altered granite are in, or are associated with, greenstone dikes. These dikes and greenstone inclusions are found as a chlorite schist, within, and adjacent to the quartz veins, and appear to be zones of weakness that localize the fracturing.

It is interesting to note that most of the gold properties in the map-area are in the albitic-rich granitic batholith and that none are found in the potassic-rich granitic batholith. Two gold properties are described within the mafic metavolcanics, but no gold values have been recorded.

Gallagher (1940, p.698) in his paper, 'Albite and Gold', stated that there is a genetic relationship between the gold mineralization solutions and igneous rocks rich in albite. This appears to be the case in the map-area. It is believed by the author that the gold deposits are due to structural control (northeast-trending fractures) but also that ore-bearing solutions and associated albitic-rich igneous rocks were derived from a common parental magma. This concept has been suggested by Gallagher (1940, p.735).

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